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Session 4pSW

Speech Workshop: Cross Language Speech Perception and Linguistic Experience: Poster Session A

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Contributed Papers

All posters will be on display from 1:00 p.m. to 4:00 p.m. To allow contributors an opportunity to see other posters, contributors of odd-numbered papers will be at their posters from 1:00 p.m. to 2:30 p.m. and contributors of even-numbered papers will be at their posters from 2:30 p.m. to 4:00 p.m.

4pSW1. Acoustic correlates of Tone 3 and Tone 4 in Mandarin. Chia-Hsin Yeh (1627 Spartan Village Apt. L, East Lansing, MI 48823)

Perceptual similarity between Tone 2 and Tone 3 in Mandarin was widely discussed in previous studies [Moore and Jongman (1997), Huang (2004), Bent (2005)]. Other tonal contrasts are hardly addressed. However, recent findings of Mandarin tones show that Tone 3 and Tone 4 are confusing in terms of descent slope. A big difference between previous studies and current ones is kinds of Tone 3 stimuli: previous studies used isolated Tone 3, namely, 214, and current studies used derived Tone 3, namely, 21, which is coarticulated with other tones. Spectrographic analysis was conducted. Descent slope and height of starting pitch were found critical between Tone 4 and derived Tone 3. Then three continua with ten instances for each were synthesized in respect of three different factors, descent slope, height of starting pitch, and height of ending pitch, which makes 30 stimuli total in three experiments, an AXB discrimination test, an identification test, and a lexical decision test. Results show that starting pitch height is a salient acoustic factor for 30 Mandarin natives, although descent slope was predicted more important. In addition, lexicon has an influence on ambiguous instances between endpoints of Tone 3 and Tone 4. Current findings may make contributions to understanding of perception, articulation, and lexicon during speech processing.

4pSW2. Intelligibility of foreign-accented speech in noise for younger and older adults. Sarah Hargus Ferguson (Dept. of Speech-Lang.-Hearing: Sci. and Disord., Univ. of Kansas, Dole Ctr., 1000 Sunnyside Ave., Rm. 3001, Lawrence, KS 66045, safergus@ku.edu), Kyung Ae Keum, Allard Jongman, and Joan A. Sereno (Univ. of Kansas, Lawrence, KS 66045)

In a previous experiment [Ferguson *et al.*, J. Acoust. Soc. Am. **118**, 1932 (2005)], young listeners with normal hearing, older adults with essentially normal hearing, and older adults with hearing loss were found to be similarly affected by the presence of a foreign accent on a word identification task in various listening conditions. This result stands in sharp contrast with an extensive literature demonstrating that the negative effect of speech distortions such as noise, reverberation, and time compression is disproportionately great for older versus younger adults. The conclusions of the previous study, however, were tempered by the presence of floor effects in the data for the older adults with hearing loss identifying accented speech in noise (12-talker babble at a signal-to-babble ratio of +3 dB). The present experiment extended the earlier one by presenting the same monosyllabic word materials to new groups of young normal, elderly normal, and elderly hearing-impaired listeners in three new signal-to-babble ratios: +6 dB, +9 dB, and +12 dB. The results will be discussed in terms of their implications for older adults interacting with foreign-accented speakers in healthcare settings. [Project supported by University of Kansas General Research Fund.]

4pSW3. The acquisition of sonorant voicing. Jagoda Sieczkowska (Inst. of Nat. Lang. Processing, Univ. of Stuttgart, Azenbergstr. 12 D-70174 Stuttgart, Germany, jagoda.sieczkowska@ims.uni-stuttgart.de)

In the view of Exemplar Theory phonetic variants of words are stored by speakers in their memory as a set of exemplars organized into clusters and

grow stronger or decay over time depending on language experience (Bybee, 2002). In Polish and French sonorant consonants in clusters are devoiced word finally, which does not occur in German and English because of phonotactical constraints. A study based on automatic speech alignment and voicing profile extraction from Polish, French, German, and English speech corpora aims at defining voicing sonorant temporal structure and voicing profile acquisition. The hypothesis is that Polish and French native speakers transfer their L1 exemplars during L2 acquisition of English and German and thus devoice sonorant. After extracting voicing profiles from recordings of native Polish and French speakers speaking English and German as an L2/L3, comparison of voicing profiles of English and German native speakers will be made in order to define the exemplar transfer.

4pSW4. Perceptual adaptation to sinewave-vocoded speech across languages. Tessa Bent (Dept. of Speech and Hearing Sci., Indiana Univ., 200 S. Jordan Ave., Bloomington, IN 47405, tbent@indiana.edu), Jeremy L. Loebach (Macalester College, Saint Paul, MN 55105), Lawrence Phillips, and David B. Pisoni (Indiana Univ., Bloomington, IN 47405)

Listeners rapidly adapt to many forms of degraded speech. What level of information drives this adaptation (e.g., acoustic, phonetic, lexical, syntactic), however, remains an open question. In the present study, three groups of listeners were passively exposed to sinewave-vocoded speech in one of three languages (English, German, or Mandarin) to manipulate the level(s) of information shared between the training languages and testing language (English). Two additional groups were also included to control for procedural learning effects. One control group received no training, while the other control group was trained with spectrally rotated English materials. After training, all listeners transcribed eight-channel sinewave-vocoded English sentences. The results demonstrated that listeners exposed to German materials performed equivalently to listeners exposed to English materials. However, listeners exposed to Mandarin materials showed an intermediate level of performance; their scores were not significantly different from the German or English groups but were also not significantly different from the two control groups. These results suggest that lexical access is not necessary for perceptual adaptation to degraded speech, but rather similar phonetic structure between the training and testing languages underlies adaptation to degraded speech. [Work supported by NIH-NIDCD T32 DC-00012 and R01 DC-000111.]

4pSW5. Assessment of perceptual assimilation before and after training. James D. Harnsberger (Dept. of Commun. Sci. and Disord., Univ. of Florida, Gainesville, FL 32611, jharns@ufl.edu)

Many non-native speech sounds are challenging to perceive and, ultimately, to acquire. The development of a model of cross-language speech perception and learning has been hampered by, among other issues, the high variability commonly observed in the perceptual assimilation of non-native contrasts due to phonetic context, talker, and a variety of indexical properties of speech. This variability may reflect persistent patterns in perception that influence learning, or it may represent only an early sensitivity to low-level phonetic detail that is attenuated as experience increases. To examine this issue, the perceptual assimilation by native speakers of American English of a variety of voicing and place contrasts from Hindi was assessed be-

fore and after training in a paired-associate word learning task. Training utilized tokens from four of the six talkers used in perceptual assimilation tasks. The purpose of the study was to determine whether or not assimilation patterns could be greatly modified and/or simplified over the course of word learning in the laboratory. If limited training resulted in large changes in perceptual assimilations, then models of cross-language speech perception and learning will need to rely on assimilation data elicited via procedures that result in stable and repeatable patterns.

4pSW6. Production of disyllabic Mandarin tones by children. Pui-san Wong (Dept. of Speech Commun. Arts and Sci., Brooklyn College, CUNY, 2900 Bedford Ave., Brooklyn, NY 11210, pswRes.@gmail.com) and Wini-fred Strange (CUNY Grad Ctr., New York, NY 10016)

Two- to six-year-old children's productions of Mandarin lexical tones in familiar disyllabic words were examined to determine the time course of tone development and the effect of complexity of fundamental frequency contours (f0) on rate of acquisition. Disyllabic tone (DT) productions of 44 children and 12 of their mothers were elicited in a picture naming task and were low-pass filtered to eliminate lexical information. Judges categorized the DTs based on the filtered stimuli without lexical support. Adults' and children's DTs were categorized with 96% and 65% accuracy, respectively. Tone accuracy increased while intersubject variability decreased with age. Children as old as 6 years did not attain adultlike accuracy. Different DT combinations developed at different rates. DTs with more complex f0 contours were more difficult for children. Substitution patterns and acoustic analysis revealed that when producing tones with large transitions at the syllable boundary, children tended to modify the f0 in the first syllable to reduce the f0 shift at the boundary of the first and second syllable, resulting in more errors in the tones in the first syllable than in the second syllable. The results suggest physiological constraints on tone development. [Work supported by NIH 5F31DC8470 and NSF.]

4pSW7. Effectiveness of a perceptually weighted measure on automatic evaluation of a foreign accent in a second language. Hiroaki Kato (NICT/ATR, 2-2-2 Hikaridai, Seika-cho, Soraku-gun, Kyoto 619-0288, Japan, kato@atr.jp), Shizuka Nakamura (GITI, Waseda Univ., Shinjuku-ku, Tokyo 169-0051, Japan), Shigeki Matsuda (NICT/ATR), Minoru Tsuzaki (Kyoto City Univ. Arts, Nishikyo-ku, Kyoto 610-1197, Japan), and Yoshinori Sagisaka (GITI, Waseda Univ./NICT, Tokyo, Japan)

An empirical study is carried out to achieve a computer-based methodology for evaluating a speaker's accent in a second language as an alternative to a native-speaker tutor. Its primary target is the disfluency in the temporal aspects of an English learner's speech. Conventional approaches commonly use measures based solely on the acoustic features of given speech, such as segmental duration differences between learners and reference native speakers. However, our auditory system, unlike a microphone, is not transparent: it does not send incoming acoustic signals into the brain without any treatment. Therefore, this study uses auditory perceptual characteristics as weighting factors on the conventional measure. These are the loudness of the corresponding speech segment and the magnitude of the jump in loudness between this target segment and each of the two adjacent speech segments. These factors were originally found through general psychoacoustical procedures [H. Kato et al., *JASA*, **101**, 2311–2322 (1997); **104**, 540–549 (1998); **111**, 387–400 (2002)], so they are applicable to any speech signal despite the difference in language. Experiments show that these weightings dramatically improve evaluation performance. The contribution of psychoacoustics to evaluation methodology of second language speech is also discussed. [Work supported by RISE project, Waseda Univ. and KAKENHI 20300069, JSPS.]

4pSW8. Effects of “catch” trials on the discrimination of American English vowels by native Japanese speakers. Takeshi Nozawa (Lang. Education Cntr., Faculty of Economics, Ritsumeikan Univ. 1-1-1 Nojihashi, Kusatsu, Shiga 525-8577, Japan)

Native Japanese speakers' ability to discriminate American English vowels was tested in two different formats, in both of which they heard three stimuli per trial. The three stimuli in each trial were produced by three different talkers. In AXB format, subjects were to decide if the second stimulus included categorically the same vowel as the first or the third stimulus. In other words, the subjects knew that one of the three stimuli was categori-

cally different from the other two. In the other format, the subjects heard three stimuli in each trial, and chose one stimulus that includes a categorically different vowel from the other two. Each vowel contrast was tested by different trials which contained an odd item out, and catch trials which contained three tokens each from each of the vowel contrast pairs. Subjects were visually presented with four boxes on a computer screen with the numbers 1, 2, and 3, and “No.” The “No” button was provided when no differences were detected. The results reveal that with catch trials included, discriminating American English vowels is a lot more difficult. The results imply the Japanese subjects' susceptibility to talker variance and inability to discriminate American English vowels categorically.

4pSW9. A twin study of speech perception and production in first and second language among Chinese children learning English as a second language. Simpson Wai-Lap Wong, Dorothy Bishop (Dept. of Experimental Psych., Univ. of Oxford, S. Parks Rd., Oxford, OX1 3UD, UK, wls Wong@gmail.com), and Connie Suk-Han Ho (Univ. of Hong Kong, Hong Kong)

The faculty of language processing in our brain develops with the constraint of our genetic dispositions and also our experiences. Do the same genetic influences affect learning of phonology in L1 and L2? This study examines the genetic and environmental effects on the individual differences on L1 and L2 speech perception and production among Chinese children learning English as a second language. By employing a twin-study design, 150 pairs of monozygotic and 150 pairs of same-sex dizygotic twins aged from 4 to 11 were tested. Children's speech perception and production in both languages were assessed with an AXB speech perception task of minimal word pairs and two picture naming tasks, respectively. Children's non-verbal IQ was also measured. Scores of accuracy will be computed for each task. Analyses will be conducted to consider the relationship between accuracy in perception and production in L1 and L2, to estimate the extent of genetic contribution to speech perception, and to determine whether heritable individual differences are accounted for by a common factor, or whether different factors influence proficiency in L1 and L2.

4pSW10. Lexical frequency, orthographic information, and first-language effects on second-language pronunciation. Ron I. Thomson (Dept. of Appl. Linguist., Brock Univ., 500 Glenridge Ave., St. Catharines, ON L2S 3A1, Canada, rthomson@brocku.ca) and Talia Isaacs (McGill Univ., Montreal, QC H3A 1Y2, Canada)

In L2 speech learning, lexical frequency may play a facilitative role, whereby perception and production of sounds found in high-frequency lexical items will develop before the perception and production of the same categories found in low-frequency lexical items (see Munro and Derwing, 2008). Orthographic information may also facilitate learning by disambiguating L2 sounds (see Erdener and Burnham, 2005), particularly in known words. This study examines the role of lexical frequency, orthographic information, and a learner's L1 in the development of L2 speech perception and production. Thirty-eight Mandarin and Slavic participants were asked to repeat a word list comprising ten target English vowels, each embedded in three separate monosyllabic verbs and varying in lexical frequency. Recordings of the L2 productions were obtained under three counter-balanced conditions: (1) after hearing an auditory prompt accompanied by the written form of the word; (2) after hearing an auditory prompt with no written form provided; and (3) with no auditory prompt but the written form provided. To measure L2 performance, L1 English listeners were asked to identify the vowel they perceived in each recorded item. Results were examined to determine what influence lexical frequency and orthographic information might have had on L2 performance.

4pSW11. A closer look at perceptual epenthesis in cross-language perception. Lisa Davidson and Jason Shaw (Dept. of Linguist., New York Univ., 726 Broadway, New York, NY 10003, lisa.davidson@nyu.edu)

Previous studies have shown that listeners have difficulty distinguishing non-native CC sequences from their CVC counterparts (e.g. Japanese [ebzo]-[ebuzo], English [zɡamo]-[zəɡamo]). Some have argued that the phonology “repairs” non-native consonant clusters with vowel insertion (“perceptual epenthesis”), causing listeners to respond that CC and CVC sequences are the same. Production studies, however, have shown that speak-

ers produce non-native CC sequences many ways, including epenthesis, changing C1, deleting C1, and prothesis. To test whether these other repairs of non-native clusters are also difficult to distinguish, English listeners ($n=37$) participated in an AX discrimination task that paired C1CVCV stimuli with CəCVCV (epenthesis), əCVCV (prothesis), CVCV (deletion), or C2CVCV (C1 change). Each of these repairs caused some difficulty and there was an interaction between repair type and manner combination (stop-stop, stop-nasal, fricative-stop, fricative-nasal). Listeners were more accurate when C1 was deleted (81% accurate), followed by epenthetic and C1 changes (both 77%), then by prothesis (59%). Furthermore, compared to previous studies testing only the epenthetic repair, presenting listeners with various repair types dramatically improves discrimination in the epenthesis condition. These results indicate that perceptual epenthesis may be a task effect and that top-down phonological influences are more complex than previously assumed. [Research supported by NSF.]

4pSW12. Native and non-native clear speech production. Rajka Smiljanic (Linguist., Univ. of Texas at Austin, 1 University Station B5100, Austin, TX 78712-0198) and Ann Bradlow (Northwestern Univ., Evanston, IL 60208)

Previous work established that both native and non-native clear speech increase intelligibility for native and proficient non-native listeners. However, non-native clear speech enhanced intelligibility less than native clear speech. In this study, we examine native and non-native conversational and clear speech productions with an eye on the differences in hyperarticulation strategies that may underlie a smaller clear speech intelligibility benefit. Results revealed a slower conversational speaking rate for non-native talkers compared with native talkers. Clear speaking rate was similar for both groups suggesting a limit in the speaking rate decrease in intelligibility enhancing clear speech. The durational distinction between tense and lax vowels was increased less in non-native speech due to the smaller speaking rate decrease in clear speech. Analyses of the stop voice onset time (VOT) showed that non-native talkers lengthened the voiced category in the negative VOT direction, while the voiceless category was lengthened less in clear speech. Finally, examination of vowel space expansion in clear speech revealed differences between the two talker groups reflecting non-native talkers' inexperience in producing some of the vowel targets. Combined, these results suggest that a complex interaction of articulatory difficulty, proficiency, and native language background determines levels of non-native clear speech intelligibility.

4pSW13. Measuring sensitivity to short-term deviations in acoustic cue correlation. Kaori Idemaru (Dept. of East Asian Lang. and Lit.s, Univ. of Oregon, Eugene, OR 97403) and Lori L. Holt (Carnegie Mellon Univ., Pittsburgh, PA 15213)

Listeners are sensitive to correlations among the multiple probabilistic acoustic cues that define speech categories. In English stop consonant productions, for example, fundamental frequency (f_0) is strongly correlated with voicing. Reflecting this regularity, perception of syllables varying in voice onset time is shifted with changes in f_0 . Such sensitivity to the long-term regularities of a language must be balanced with enough flexibility that speech perception is able to accommodate deviations from these regularities, such as those that may arise variations from idiolect, dialect, or accented speech. The present experiments manipulate short-term acoustic cue correlations experienced in online perception to investigate the interplay between sensitivity to long-term and short-term acoustic cue correlation. Using overt categorization and eyetracking, the present results indicate that speech categorization is influenced by local shifts in acoustic cue correlations that deviate from long-term regularities of English. These experiments further examine the time course of this short-term learning and the degree to which it generalizes. The data suggest that listeners continually monitor speech input for regularity and tune online speech perception in relation to these regularities.

4pSW14. Articulatory analysis of foreign-accented speech using real-time MRI. Joseph Tepperman (Viterbi School of Eng., Univ. of Southern California, 3740 McClintock Ave., EEB 400, Los Angeles, CA 90089, tepperma@usc.edu), Erik Bresch, Yoon-Chul Kim, Louis Goldstein, Dani Byrd, Krishna Nayak, and Shrikanth Narayanan (Univ. of Southern California, Los Angeles, CA 90089)

We present the first study of nonnative English speech using real-time MRI analysis. The purpose of this study is to investigate the articulatory nature of "phonological transfer"—a speaker's systematic use of sounds from their native language (L1) when they are speaking a foreign language (L2). When a non-native speaker is prompted to produce a phoneme that does not exist in their L1, we hypothesize that their articulation of that phoneme will be colored by that of the "closest" phoneme in their L1's set, possibly to the point of substitution. With data from three native German speakers and three reference native English speakers, we compare articulation of read phoneme targets well documented as "difficult" for German speakers of English (/w/ and /dh/) with their most common substitutions (/v/ and /d/, respectively). Tracking of vocal tract organs in the MRI images reveals that the acoustic variability in a foreign accent can indeed be ascribed to the subtle articulatory influence of these close substitutions. This suggests that studies in automatic pronunciation evaluation can benefit from the use of articulatory rather than phoneme-level acoustic models. [Work supported by NIH.]

4pSW15. The perception of speech and nonspeech analogs by first- and second-language speakers. Paul Iverson, Anita Wagner, and Stuart Rosen (Res. Dept. Speech Hearing and Phonetic Sci., University College London, 2 Wakefield St., London WC1N 1PF, UK)

There are marked differences in how native speakers of Sinhala and English perceive the English /w/-/v/ distinction; Sinhala speakers who have learned English as a second language are typically near chance at identification and have less than half the discrimination sensitivity of native English speakers. This poor discrimination ability is remarkable because the acoustic cues for /w/ and /v/ are varied, being contrastive in formant frequencies, amount of friction, and amplitude envelopes. The present project explored these differences in auditory sensitivity by manipulating speech and nonspeech stimuli, with the aim of investigating how close an auditory stimulus needs to be to natural speech in order for cross-language perceptual differences to emerge. Synthesized VCV speech stimuli were created to model natural recordings. Nonspeech stimuli were created by removing dynamics from the stimuli (e.g., flat pitch and amplitude, no formant movement), producing a "buzz" that was acoustically similar to the speech stimuli. Discrimination results for these stimuli will be reported for native speakers of Sinhala and English, in order to evaluate whether cross-language specialization for speech may occur at a precategorical auditory-phonetic level of processing, or whether specialization is contingent on the stimuli being perceived as intelligible speech.

4pSW16. Proficiency instrumentation for cross language perception studies. Jared Bernstein (Pearson, 299 S. California Ave., Ste. 300, Palo Alto, CA 94306, Jared.Bernstein@Pearson.com)

Studies in cross language speech perception sometimes use self-reported values of language proficiency as an independent variable. In relation to other measurement methods, proficiency self-reports have been found susceptible to several sources of bias including demographic variables and proficiency level itself [S. Yamashita, *Six Measures of JSL Pragmatics*, U. Hawaii Press (1996)]. An inaccurate scaling of an independent variable can limit the precision of performance models that are based on that variable's relation to the dependent variable. This paper presents a convenient method (Versant tests) for measuring spoken language proficiency that locates subjects on a 60 point scale with a standard error measurement of less than 3 points, thus reliably locating subjects into 20 levels along a linear continuum of proficiency. The testing procedure takes about 15 minutes to complete. The test-retest reliability of Versant scores for spoken English and Spanish are 0.97 and 0.96, respectively, both with correlations greater than 0.85 with independent human rated tests. The development, operation, and psychometric properties of the Versant tests are presented briefly, along with examples of their use in evaluating language instruction programs and standard listening comprehension tests.

4pSW17. Why do adults vary in how categorically they rate the accuracy of children's speech? Eden Kaiser (Prog. in Linguistic, Univ. of Minnesota, 214 Nolte Ctr., 315 Pillsbury Dr. SE, Minneapolis, MN 55455, kaise113@umn.edu), Benjamin Munson (Univ. of Minnesota, Minneapolis, MN 55455), Fangfang Li (Univ. of Lethbridge, Lethbridge, AB T1K 3M4, Canada), Jeff Holliday (Ohio State Univ., Columbus, OH 43210), Mary Beckman (Ohio State Univ., Columbus, OH 43210), Jan Edwards, and Sarah Schellinger (Univ. of Wisconsin-Madison, Madison, WI 53706)

In a recent experiment using continuous visual analog scales (VAS) to examine adults' perception of children's speech accuracy, listeners varied in the extent to which they categorically perceived children's English and non-English productions [Munson *et al.*, American Speech-Language-Hearing Association (2008)]. Some listeners utilized all points on the VAS line for their responses, while others grouped responses around discrete locations on the line. It is hypothesized that differences in categoricity of responses across listeners might relate to listeners attending to either categorical linguistic information (i.e., identifying phonemes in a word, which would promote more categorical labeling) or gradient indexical information (i.e., identifying the child's sex or age, which would promote more continuous labeling). If this is true, it should be possible to elicit differences in categoricity of fricative "goodness" judgments in individual listeners by priming them to listen to linguistic variables (by interleaving fricative judgment trials with trials in which they categorize the vowel spoken by the child) or indexical variables (by interleaving fricative judgment trials with trials in which they identify the child's sex). This paper reports on an experiment designed to test this. Results will help us better understand individual response patterns in cross-language speech perception experiments.

4pSW18. Perceptual studies of two phonological voicing patterns. Scott Myers (Dept. of Linguist., 1 Univ. Sta. B5100, Univ. of Texas, Austin, TX 78712, s.myers@mail.utexas.edu)

Two of the most common phonological patterns in the world's languages are final devoicing and regressive voicing assimilation. In final devoicing, there is a contrast in obstruent voicing generally, but in word-, phrase-, or syllable-final position, only voiceless obstruents are allowed (e.g., Dutch, Russian, Walloon). In regressive voicing assimilation, the first of a sequence of two obstruents is required to agree with the second in voicing (e.g., Russian, Catalan, Hebrew). These phonological patterns can be related to patterns of speech production: anticipation of the spread glottis posture in pause and laryngeal coarticulation within consonant clusters. The studies reported here investigate the perceptual consequences of these coarticulatory effects. Native speakers of English listened to words contrasting in the voicing of the final consonant (cease/seize) and identified which word they heard. The words were excised from utterance-final position or from phrase-medial position preceding a vowel, nasal, a voiced obstruent, or a voiceless obstruent. The subjects averaged about 90 percent correct identification. But they still displayed a significant bias toward identifying as voiceless the final consonant in utterance-final words as well as in words preceding a voiceless obstruent. This pattern of identification errors could be the diachronic basis of the phonological patterns.

4pSW19. The relationship between speech perception and production in second language learners. Bing Cheng (English Dept., Inst. of Intl. Studies, Xi'an Jiaotong Univ., Xi'an, China, 710049) and Yang Zhang (Univ of Minnesota, Minneapolis, MN 55455)

This study aims to examine the relationship between perception and production skills in second language learners. Thirty-nine Chinese college students who have received at least eight years of English-as-a-second-language (ESL) education in school participated in the study. The data were collected using two programs: HearSay from Communication Disorders Technology Inc., Indiana, and a perceptual test program developed by Yang Zhang at the University of Minnesota. Digital recordings of each participant's production of the individual words used in the perceptual test program were rated in the scale of 1 to 5 by two native speakers of English. Results demonstrated the existence of complex relationships between perception and production in ESL learners. Overall, the consonants demonstrated a significant positive correlation between perception and production ($p < 0.01$) with voicing showing strongest effect. Vowels, on the other hand, did not show significant correlations in any of the five categories examined: tense/lax, high/low, front/back, diphthong, and vowel insertions. Four patterns were identified for the individual phonemes: (a) good perception and good production, (b) poor perception and poor production, (c) good percep-

tion and poor production, and (d) poor perception and good production. The results are discussed with respect to speech learning models and practical instructional approaches.

4pSW20. Indexical perception in Chinese: The influence of first-language (L1) Taiwanese on second-language (L2) Mandarin. Yufen Chang (2451 E. 10th St., Apt. 909, Bloomington, IN 47408, yufchang@indiana.edu)

A pilot study on indexical perception in Chinese hypothesized that L1 Taiwanese speakers' L2 Mandarin production could be detected as having a nonnative accent. If the nonnative accent was detectable, what phonetic properties (the phonetics of consonants or vowels, or the prosody) did L1 Taiwanese speakers' Mandarin exhibit such that these attributes entailed indexical information? Additionally, the study argued that L1 Mandarin speakers would show higher sensitivity to the nonnative accent than L1 Taiwanese speakers. The results have shown that only in sentence production, the sentences being either low-pass filtered or unfiltered, could the L1 Taiwanese talkers be possibly indexed correctly. It was also found that the listeners perceived more accurately when they encountered retroflex stimuli in monosyllabic word condition. Based on these findings, it was concluded that the prosody and the retroflex consonants seemed to reveal much of the talker's L1 information. However, concerning the hypothesis that L1 Mandarin speakers were more sensitive to the nonnative accent, the results did not support this. The findings in this pilot study are preliminary, given the fact that the corpus was small. A bigger-scale study is being carried out to gain more insights into indexical perception in Chinese.

4pSW21. Automatic auditory discrimination of vowels in simultaneous bilingual and monolingual speakers as measured by the mismatch negativity (MMN). Monika Molnar, Shari Baum, Linda Polka (McGill Univ., 1266 Pine Ave. W, Montreal, H3G 1A8 Canada, monika.molnar@mcgill.ca), Lucie Menard (Universite du PQ à Montréal, Montreal, Canada), and Karsten Steinhauer (McGill Univ., Montreal, H3G 1A8 Canada)

MMN responses reflect whether language users have developed long-term memory traces in response to phonemes and whether they are able to perceive small acoustic changes within speech sound categories. Subtle acoustic changes within phonemes are often irrelevant to monolingual perceivers, but can be crucial for bilingual perceivers if the acoustic change differentiates the phonemes of their two languages. In the present study, we investigated whether bilinguals are sensitive to such acoustic changes. We recorded MMN responses from monolingual (English, French) and simultaneous bilingual (English/French) adults using an auditory oddball paradigm in response to four vowels: English [u], French [u], French [y], and an acoustically-distinct (control) [y]. In line with previous findings, monolinguals were more sensitive to the phonemic status of the vowels than to the acoustic properties differentiating the sounds. Bilingual speakers revealed a different pattern; they demonstrated overall slower discrimination responses to all sounds, but showed almost equal sensitivity to phonemic and phonetic/acoustic differences. The results suggest that bilingual speakers exhibit a more flexible but less uniquely-specified perceptual pattern compared to monolingual speakers.

4pSW22. Comparison between Japanese children and adult's perception of prosodic politeness expressions. Takaaki Shochi (Div. of Cognit. Psych., Kumamoto Univ., Kurokami 2-40-1, Kumamoto City, 860-8555, Japan, shochi38@gmail.com), Donna Erickson (Showa Univ. of Music, Kawasaki-city, Kanagawa pref., 215-0021, Japan), Albert Riiliard (LIMSI-CNRS, BP 133 F-91403 Orsay cedex, France), Kaoru Sekiyama (Kumamoto Univ., Kurokami 2-40-1, Kumamoto city, 860-8555, Japan), and Veronique Auberge (Domaine Universitaire, BP46 F-38402 Saint Martin d'Heres cedex, France)

Previous work examined the contribution of audio and visual modalities for perception of Japanese social affects by adults. The results showed audio and visual information contribute to the perception of culturally encoded expressions, and show an important synergy when presented together. Multimodal presentation allows foreign adult listeners to recognize culturally encoded expressions of Japanese politeness which they cannot recognize with an audio-only stimuli. This current work analyzes the recognition performance of politeness expressions by Japanese children 13 to 14 years old.

Stimuli, based on one sentence with an affectively neutral meaning, are performed with five different expressions of politeness. Subjects listen three times to each stimulus and judge the intended message of the speaker. The stimuli are presented as audio-only, visual-only, audio-visual. Listeners rate the social status of the hearer and the degree of politeness on a nine-point scale ranging from polite to impolite. The results are analyzed to capture the relative ability of adults and children to use both modalities to recognize social affects. [This work was supported in part by Japanese Ministry of Education, Science, Sport, and Culture, Grant-in-Aid for Scientific Research (C) (2007–2010): 19520371 and SCOPE (071705001) of Ministry of Internal Affairs and Communications (MIC), Japan.]

4pSW23. Do you want to pronounce correctly in a foreign language? Start music lessons! Barbara E. Pastuszek-Lipinska (School of English, Adam Mickiewicz Univ., al. Niepodleglosci 4, 61-874 Poznan, Poland)

Music education is one of the human activities that requires the integration of all human senses and the involvement of all cognitive processes: sensory, perceptual, and cognitive learning, memory, emotion, and auditory and motor processes, music has tended to figure only marginally in an approach to second-language acquisition. In the presentation will be reviewed recent research results on the influence of music lessons on second language speech processing. The presentation will draw a comparison between second language acquisition processes and first language acquisition processes. It will be also provided concise review of the possible explanations of the influence of music on second language speech processing. The review will include acoustic, phonological, neuroscientific, and psycholinguistic approaches.

4pSW24. Mandarin-English bilinguals' accented first-language (L1) vowel production. Haisheng Jiang (School of Lang. and Lit., Univ. of Aberdeen, Aberdeen, AB24 3FX, UK, h.jiang@abdn.ac.uk)

The L1 phonetic categories established in childhood may undergo modification when similar L1 and L2 sounds interact in the process of L2 learning [J. Flege, *Speech perception and linguistic experience: Issues in cross-language research* (1995)]. In this study, Mandarin vowel production by the Mandarin-English bilinguals was presented to Mandarin as well as English listeners for goodness rating. The results showed that both Mandarin-English bilinguals of high L1 use and those of low L1 use differed significantly from Mandarin monolinguals in the production of /y/, a vowel with no counterpart in English. An analysis of inter-speaker variability indicated that some individual Mandarin-English bilinguals, including both speakers of high L1 and low L1 use, were accented in the production of /y/, and /au/. Possible acoustic properties contributing to their accentedness were identified. L2 English learning led to some Mandarin-English bilinguals carrying some English characteristics in their L1 Mandarin vowel production. This study provides further evidence for the claim that the L1 phonetic system established in childhood is susceptible to change. It contributes to the less well-studied field of L2 influence on L1.

4pSW25. Assessing phonetic talent in second language performance: The relationship between perception abilities in the native and the second language and production. Matthias Jilka (Institut of English Linguist., Univ. of Stuttgart, Heilbronner Str. 7, 70174 Stuttgart, Germany, jilka@ifla.uni-stuttgart.de), Giusy Rota (Univ. of Stuttgart, 70174 Stuttgart, Germany), and Susanne Reiterer (Univ. of Tuebingen, 72076 Tuebingen, Germany)

An extensive project that aims to assess innate phonetic talent is introduced. It investigates language performance of 103 native speakers of German in their native language, in English and (to a limited degree) in Hindi. The project's original priority is to establish a talent score that serves as the basis for a neurolinguistic study which attempts to find correlates between phonetic talent and brain anatomy/function. For this purpose tasks investigating neurobiological, psychological, and other factors influencing performance are also conducted. Innate talent is to be distinguished from superficial proficiency by limiting or eliminating the influence of interfering factors such as language experience. The test subjects are investigated with respect to different manifestations of their production (e.g., quasi-spontaneous speech, reading), perception (e.g., discrimination, identification), and imitation abilities in both German and English. A first analysis of the interactions between all perception and production scores

shows a significant correlation at the level of $p < 0.05$. The correlation is especially high ($p < 0.01$) between perception tasks involving the interpretation of intonational features of both English and German and production abilities (again both in German and English), suggesting a certain cross-language predictive power.

4pSW26. Speech perception assessment and training system (SPATS-ESL) for speakers of other languages learning English. James D. Miller, Roy Sillings, Charles S. Watson, and Diane Kewley-Port (Commun. Disord. Technol., Inc., 501 N. Morton St., Sta. 215, Bloomington, IN 47404)

The SPATS software system, originally developed for the hearing-impaired, has been modified for use with ESL learners with TOFEL (pbt) scores near and well above 500. SPATS-ESL includes the identification of syllable constituents: onsets, nuclei, and codas, as well as sentence recognition. The syllable constituent tasks include the progressive introduction of increasing numbers of constituents until the learner becomes adept at the identification of 45 onsets, 28 nuclei, and 36 codas presented by eight talkers in a variety of phonetic contexts. The sentence task emphasizes increasing speed and decreasing errors in the recognition of short, meaningful sentences spoken by a variety of talkers. The sentences are presented in a background of multi-talker babble at five signal-to-noise ratios: +10, +5, 0, -5, and -10 dB. The syllable constituent and sentence tasks are interleaved throughout training. In constituent training, SPATS uses a proprietary training algorithm, Adaptive Item Selection (AIS), which automatically focuses training on individuals' items of intermediate difficulty and is independent of their language history. Proctored tests allow certification of a learner's English speech perception in relation to native-speaker performance.

4pSW27. On-line perception of lexical stress in English and Spanish: The effects of sentence intonation and vowel reduction. Marta Ortega-Llebaria (Dept. of Spanish and Portuguese, Univ. of Texas at Austin, Austin, TX 78712, ortegallebaria@att.net)

Previous research shows that speakers of stress-accent languages rely on pitch-accents to perceive word stress in sentences spoken with declarative intonation, while in unaccented sentences, like post-focal contexts, they rely on other cues, i.e., duration in Spanish or vowel reduction in English. However, there is no experimental evidence on the effect that sentence intonation has in the "on-line" perception of word stress across languages. This experiment examines whether listeners detect word stress faster in unaccented stretches of speech that are preceded by a landmark in the sentence melody, i.e., the focal pitch-accent that always precedes a post-focal sentence, than in unaccented contexts not preceded by a landmark, i.e., reporting clauses. Results show that Spanish listeners identified target words at the beginning and end of post-focal contexts with similar reaction times, while in reporting clauses, target words placed at the end were identified faster than those placed at the beginning. Preliminary results for English show no significant differences. Thus, Spanish listeners re-weight cues to word stress on-line taking into account the patterns of sentence intonation. Sentence melody does not have such a strong effect in English, possibly because vowel reduction is a sufficient cue to an effective perception of word stress.

4pSW28. A cross-language study of compensatory response to formant-shifted feedback. Takashi Mitsuya, Ewen N. MacDonald (Dept. of Psychol., Queen's Univ., Kingston, Canada), David W. Purcell (Univ. Western Ontario, London, Canada), and Kevin G. Munhall (Queen's Univ., Kingston, Canada)

Previous experiments in speech motor learning have demonstrated that the perception of our own voice while we speak plays a role in the control of fundamental and formant frequencies and vocal amplitude. When feedback is changed in real time, subjects alter speech production in attempt to compensate for the perturbation. By testing Japanese talkers in their native and a less familiar language (as well as English-speaking controls), we examine how this perception-production process is influenced by language. In the first study, native Japanese speakers produced an English word with formant-shifted feedback. In the second experiment, native Japanese speakers produced a Japanese syllable with altered feedback and produced an

English word that contained a similar vowel with normal feedback. The results were compared with data from English controls and suggest that the compensatory behavior is not language dependent.

4pSW29. Linguistic experience's influence on foreign accent detection in short, slightly accented speech. Hanyong Park (Speech Res. Lab., Indiana Univ., 1101 E. 10th St., Bloomington, IN 47405, hanyongpark@indiana.edu)

This study examined how a listener's linguistic experience affects the detection of foreign accent in short, slightly accented speech. Two factors were considered: Age of arrival in a second-language (L2) speaking country (AOA), and length of residence in that country (LOR). Two listener groups with the same native language (L1: Korean) but with different AOA and LOR judged the nativeness of short stimuli produced by 4 Korean-English bilinguals and 2 native speakers of American English. The stimulus length ranged from the vowel /a/ to monosyllabic and disyllabic English words. To investigate the listeners' sensitivity patterns to different linguistic structure, the monosyllabic corpus included stimuli having both natural (i.e., CV) and unnatural syllable structures (i.e., CCV, CVC, and CCVC) as well as various segments in terms of Korean phonotactics. Results show that: (1) more experienced with L2 led to higher sensitivity to a foreign accent; (2) AOA affects foreign accent detection more than LOR; and (3) the non-native listeners were not sensitive to different linguistic structures, except in different CCV types by the more experienced listeners. The results suggest that a listener's sensitivity to a foreign accent develops up to a certain degree, according to L2 experience.

4pSW30. Asymmetries in the mismatch negativity response to vowels by French, English, and bilingual adults: Evidence for a language-universal bias. Linda Polka, Monika Molnar, Shari Baum (School of Commun. Sci. and Disord., McGill Univ., 1266 Pine Ave. W., Montreal, QC Canada, linda.polka@McGill.ca), Lucie Menard (Universite du Quebec à Montréal, QC Canada), and Karsten Steinhauer (McGill Univ., Montreal, QC, Canada)

In infants, discrimination of a vowel change presented in one direction is often significantly better compared to the same change presented in the reverse direction. These directional asymmetries reveal a language-universal bias favoring vowels with extreme articulatory-acoustic properties (peripheral in F1/F2 vowel space). In adults, asymmetries are observed for non-native but not for native vowel contrasts. To examine neurophysiological correlates of these asymmetries we recorded MMN responses from monolingual (English, French) and simultaneous bilingual (English/French) adults using an oddball paradigm with four vowels: English [u], French [u], French [y], and an acoustically-distinct [ɥ]. All vowels were tested in four conditions with each vowel serving as deviant and standard. Within each vowel pair, MMN responses were larger and earlier when the deviant vowel was more peripheral. This pattern was consistent across the language groups and was observed for within-category (within [u]; within [y]) and for cross-category vowel pairs ([u] versus [y]). Findings indicate that a bias favoring peripheral vowels is retained in the neural pre-attentive processing of vowels in adults. As in infant behavioral findings, this bias is independent of the functional status of the vowel pair. Implications for the natural referent vowel model [Polka and Bohn (2003)] will be discussed.

4pSW31. The effect of accent on toddlers' story comprehension and word recognition. Brittan A. Barker and Lindsay E. Meyer (Dept. of COMD, Louisiana State Univ., 63 Hatcher Hall, Baton Rouge, LA 70803)

The current study sought to enrich the developmental research and contribute to the ever-growing knowledge about talker-specific spoken language processing by examining the affect of accent on toddlers' ability to comprehend a story. A total of 24 children aged 30–42 months participated in the first study employing a between-subjects design. Talker accent (native versus non-native) served as the independent variable and story comprehension accuracy served as the dependent variable. It was predicted that the children listening to the story in their native accent would perform significantly better on the comprehension task than those listening to the non-native accent. The hypothesis was not supported; there was no significant difference between the listeners' performance [$t(22) = .169, p > .05$]. An ongoing, follow-up study was conducted to further explore the surprising results. The affect of accent on word recognition skills in these same children is currently being tested. The complete data set of the second study will be presented. It is hypothesized that the toddlers will have significantly more difficulty recog-

nizing the words spoken in a non-native accent. These results would echo previous talker-specific word recognition results [Ryalls and Pisoni (1997)] and suggest that talker-specific information may affect low-level speech perception but not higher-level language comprehension.

4pSW32. Cross-linguistic variation in language similarity classification. MaryAnn Walter (Dept. of Linguist., Northwestern Univ., 2016 Sheridan Rd., Evanston, IL 60208, m-walter@northwestern.edu)

This study aims at identifying factors that make language sound structures seem more or less similar to English, and how those similarity judgments change according to the listener's native language. Listeners from four different native language groups (English, Mandarin Chinese, Korean, and Turkish) sorted a group of 17 genetically and geographically diverse languages in terms of their sound-based distance from English. Placements of individual languages were analyzed, as well as groupings of similarly ranked languages and correlations among overall ranking structures of the different groups. Bilingual listeners exhibit more variability in their rankings than monolingual English speakers, rank their own language as less similar to English than other groups do, and rank languages of neighboring groups the least similar to it of all. Ranking correlations between language groups are significant, varying somewhat in magnitude depending on geographical proximity and typological/genetic relatedness of the listener group languages. This reflects the presence of consistent groupings within ranking structures for all language groups, which depend on sound-based factors such as the presence of perceptually salient speech sounds. These results enable predictions about relative intelligibility among international English users, native and non-native. [Work supported by a Mellon Postdoctoral Fellowship awarded by the Woodrow Wilson Foundation.]

4pSW33. Acoustic similarities between front rounded and back unrounded vowels as evidenced by French /ø/ and /u/ produced by Japanese-speaking learners. Takeki Kamiyama (Laboratoire de Phonétique et Phonologie (UMR 7018) CNRS/Sorbonne Nouvelle, 19, rue des Bernardins, 75005 Paris, France, Takeki.Kamiyama@univ-paris3.fr)

French high back rounded /u/ is characterized by a concentration of energy in the low frequency zone (< 1000 Hz) due to the grouping of the first two formants, and midhigh front rounded /ø/ by a balanced distribution of formants, with F2 located around 1500 Hz. Japanese-speaking learners of French (JSL), who have difficulty differentiating /ø/ and /u/ both in perception and production, tend to produce, for both, Japanese-like /u/, which is fronted and less rounded, with a formant structure similar to that of French /ø/. Our perception experiment using 18 tokens each of /u y ø/ produced by five JSL shows that the 16 native speakers of French (NF) tested perceived mainly /ø/ when they heard those stimuli intended as /u/ by JSL but produced with a high F2 between 1100 and 1600 Hz, with a mean goodness rating of 2–4.5 out of 5 for /ø/. Another perception test conducted with stimuli synthesized using Maeda's articulatory synthesis (VTCalcs) shows that the 16 NF examined tended to identify vowels synthesized as front rounded vowels and back unrounded vowels both as front unrounded ones (/ø/ and /æ/, respectively), which indicates the acoustic similarities of both types of vowels.

4pSW34. Relation of perception training to production of codas in English as a second language. Teresa Lopez-Soto (Dept. of English Lang., Univ. of Seville, Palos de la Frontera, Sevilla 41004, Spain and Indiana Univ., Bloomington, IN 47405) and Diane Kewley-Port (Indiana Univ., Bloomington, IN 47405)

A preliminary study has been conducted to discover whether moderate amounts of speech perception training improve accurate production even though production is not trained. The study recruited one group of eight Spanish adults who had resided less than 10 years in the USA. A set of 13 word-final English consonants was selected for training from a SPATS software module. On days 1 and 5, the group participated in both perception and production tasks with the 13 codas (pre- and post-tests). On days 2–4, the group trained with feedback for 1 h mostly with VC syllables and occasionally with sentences (speech recorded from multiple talkers). Results show: (1) with 3 h training, Spanish listeners' perception improved significantly across the 13 codas, with greater improvement on consonant clusters than on singletons; (2) for consonants not accurately produced in the pretest, many substantially improved after only perception training; (3) several consonants

with large gains in perception also showed the large improvements in production. The results from this study suggest that training only with perception can improve speech production. Experience with this protocol lays the groundwork for a series of studies to examine how perception and production are linked in learning a new language.

4pSW35. Confusion direction differences in second language production and perception. Yen-Chen Hao and Kenneth de Jong (Dept. of Linguist., Indiana Univ., 322 Memorial Hall, 1021 E. 3rd St., Bloomington, IN 47405)

This study examines differences between confusions found in productions and perceptions of learners of English. Twenty Korean EFL learners engaged in three tasks involving obstruents placed in different prosodic positions: (a) identification of native English productions, (b) reading from orthographic prompts, and (c) mimicry of native English productions. Recordings of reading and mimicry were presented to 50 native English listeners for identification. This paper compares patterns of errors found for 10 intervocalic obstruents before and after a stress, since previous studies showed that Korean does not exhibit stress-induced differences in consonant allophones. Similarity estimates using Luce's similarity choice model were regressed across the two intervocalic positions. We found robust correlations despite allophonic differences in English, suggesting a component of L1 transfer in all three tasks. Examining bias parameters, however, revealed systematic differences in the direction of the resulting errors, which is task-dependent. Identification and mimicry tended to underestimate allophonic shifts due to stress, and so to create more voiceless to voiced errors in post-stress environments. Reading productions exhibited error directions in exactly the opposite directions, suggesting Korean learners produced the stress but not the corresponding allophonic variations. These patterns indicate very different error outcomes in production and perception.

4pSW36. Maintenance of /e-ε/ in word-final position as a phonemic and morphemic contrast in Canadian French. Franco Law, II and Winifred Strange (Program in Speech-Lang.-Hearing Sci., CUNY Graduate Ctr., 365 5th Ave., New York, NY 10016, flaw@gc.cuny.edu)

Many dialects of French have merged /e-ε/ to /e/ in word-final context. The present study investigated the stability of this contrast in Canadian French. Productions of four Canadian French-dominant speakers (two monolingual, two bilingual) were recorded and analyzed. Real (e.g., "thé") and nonsense (e.g., "gispaïs") words ending with /e/ or /ε/ were used, as well as real and nonsense verbs distinguished morphosyntactically by the same vowel contrast (e.g., first person singular future "parlerai" versus first person singular conditional "parlerais"), all embedded in carrier sentences. Results showed that participants maintained spectral and duration distinction for the vowel contrast when preceded by labial, coronal, and back stops in real and nonsense words. All participants showed varying degrees of coarticulation for /e/ when preceded by /t/; /ε/ was spectrally lower than in other contexts. Three of the four participants maintained a stable distinction in morphosyntactic context: monolinguals exhibited the best retention of the distinction, whereas the bilinguals had partially or completely overlapping distributions, merging /e-ε/ to /e/, not /ε/. These patterns suggest difficulties in perception of this contrast for English late L2 learners of French, due to the fact that this contrast is not phonotactically possible in English. [Work supported by NIH F31DC008075.]

4pSW37. On prosodic variation and pronunciation aptitude: A case study of German speakers of English. Volha Anufryk and Grzegorz Dogil (Azenbergstr. 12, 70174 Stuttgart, Germany)

The present study investigates prosodic variation, as realized by L1 German speakers of varying pronunciation aptitude (below-average, average, and above-average) in comparison with native speakers of English. The results demonstrate the frequency of distribution of various pitch contours in read and spontaneous speech samples, English and German, on both the phonological (ToBI pitch accents and boundary tones) and phonetic levels. The latter is analyzed using a parametric intonation model (Moehler 2001). On the phonological level the rising contours, i.e., boundary tones and pitch accents, have a wider distribution in German as well as English productions of the German subjects as compared to the L1 English speakers. In German the percentages in all the aptitude groups are almost equal covering about 50% of all contours. Their English language realizations, on the other hand, are marked by a scarcer distribution of the rising pattern, with the highest

percentages in the below-average and average groups and lowest by the above-average speakers. Consequently, there is a clearcut tendency for the native pattern in the German speakers' samples. Nonetheless there is evidence for accommodation to the English variation pattern, which is strongest in the above-average aptitude group.

4pSW38. Native and non-native vocal imitation by vocalists and nonvocalists. Terry L. Gottfried and LaDonna Hayden (Dept. of Psychol., Lawrence Univ., P.O. Box 599, Appleton, WI 54912, gottfrit@lawrence.edu)

Several studies [e.g., Slevc and Miyaki, Psychol. Sci. 17, 675–681 (2006)] have demonstrated that musical ability predicts phonological accuracy in second language learning. The present study examined whether vocal musicians' diction training affected their immediate imitation of familiar (English nonwords) and unfamiliar (Mandarin) syllables. Participants were 19 nonmusic majors (recruited from introductory linguistics) and 19 vocal music majors (who had completed three of four vocal diction classes). All participants heard a list of eight English nonwords and eight Mandarin words from a recording and repeated each word or nonword to the best of their ability. These recordings were rated (by two bilingual judges) on the overall accuracy of word repetition and vowel and consonant accuracy. Participants, regardless of group, repeated English nonwords more accurately than Mandarin words. Vocalists repeated both English nonwords and Mandarin words more accurately than the nonvocalists. This could indicate that vocalists' experience in diction training improved their ability to repeat any speech sound. Acoustical analyses of these vocal imitations are currently being conducted, and future studies will examine whether musicians without diction training are better than nonmusicians in vocal imitation.

4pSW39. Gestural drift in Spanish-English speakers. Stephen Tobin (Dept. of Psych., Univ. of Connecticut, 406 Babbidge Rd., Unit 1020, Storrs, CT 06269-1020, stephen.tobin@uconn.edu)

Voice onset times (VOTs) and second vowel formants (F2s) of native speakers of Spanish were examined to extend findings on perceptually guided changes in speech production [M. L. Sancier and C. A. Fowler, J. Phon. 25, 421–426 (1995)]. Participants were recorded producing English and Spanish sentences after stays in the U.S. and in Spanish-speaking countries. Participants' English and Spanish VOTs were both significantly shorter after a stay in a Spanish-speaking country than after a stay in the U.S., supporting previous findings. While S1's F2s were significantly lower following exposure to Spanish, as expected based on earlier results [A.R. Bradlow, J. Acoust. Soc. Am. 97(3), 1916–1924 (1995)], S2's F2s increased. We attribute this effect to gender, pending further data acquisition. We propose that not only inter-gestural timing but also the gestural targets themselves are affected by ambient language. The systematic effect of language exposure on F2 is consistent with language-specific articulatory settings [B. Honikman (1964); Gick et al., Phonetica 61, 220–233 (2004)].

4pSW40. Vowel duration in Mexican heritage English. Kenneth Konopka and Janet Pierrehumbert (Dept. of Linguist., Northwestern Univ., 2016 Sheridan Rd., Evanston, IL 60208, k-konopka@northwestern.edu)

Mexican heritage English (MHE) speakers in Chicago comprise a unique population of native English speakers; their speech is often regarded by non-ethnic (NE) speakers as Spanish-accented English in spite of the fact that they may have low or no proficiency in Spanish. Vowels were analyzed from recordings of wordlist readings by MHE, NE, and adult Mexican ESL speakers (L2E) from a single Chicago community ($N=15F$, $10F$, and $12F$, respectively). The analyses indicate that MHE vowel durations correspond to NE durations for the dimoraic (long) vowels, but correspond to the Spanish-accented vowels of L2E for the monomoraic (short) vowels. Thus the range of duration between short and long vowels is compressed for MHE vowels, reflecting the NE norm for long vowels, and the Spanish-influenced minimum for short vowels. Sociophoneticians often rely on vowel formant frequency plots to provide a quantitative measure of dialect identity that may correlate with a variety of regional and social factors. The current study provides evidence that vowel duration is a phonological contrast in the MHE dialect that reflects the influence of language contact on vowel properties that are not captured by vowel plots alone.

4pSW41. The perception of intermediate phonological relationships. Kathleen Currie Hall (Dept. of Linguist., Ohio State U., 1712 Neil Ave., Columbus, OH 43210, kchall@ling.osu.edu)

It has been shown that pairs of segments that are allophonic in a language are perceived as being more similar than pairs that are contrastive in a language [Boomershine et al., (2008)]. There is also evidence that neutralized contrasts in a language are perceived as more similar than non-neutralized contrasts [Hume and Johnson (2003)]. Third, there is evidence that phonological relationships should be defined along a continuum of predictability, rather than as a categorical distinction between “allophonic” and “contrastive” [Hall (2008)]. In combination, these facts predict that pairs of segments that fall along a cline of predictability of distribution should also

fall along a cline of perceived similarity. This paper presents results of a perception experiment that tests this prediction by examining the perceived similarity of four pairs of sounds in German: (1) [t]-[tʃ], which is almost fully contrastive (unpredictably distributed); (2) [t]-[d] and (3) [s]-[ʃ], which are each partially contrastive (partially predictably distributed); and (4) [x]-[ç], which is almost fully allophonic (completely predictably distributed). If the notion of a cline of predictability is correct, these four pairs will align themselves along a cline of similarity with [t]-[tʃ] being rated as the most distinct and [x]-[ç] as the most similar.

FRIDAY MORNING, 22 MAY 2009

SKY BRIDGE AUDITORIUM, 8:45 TO 10:10 A.M.

Session 5aSWa

Speech Workshop: New Perspectives on Models of Cross-Language Speech Perception

Ann R. Bradlow, Chair

Dept. of Linguistics, Northwestern Univ., Evanston, IL 60208

Chair's Introduction—8:45

Invited Papers

9:00

5aSWa1. Accounting for the accented perception of vowels: Universal preferences and language-specific biases. Ocke-Schwen Bohn (English Dept., Aarhus Univ., J.-C.-Skous Vej 5, DK-8000 Aarhus C, Denmark) and Linda Polka (School of Commun. Sci. and Disord., Montreal, PQ, H3G1A8, Canada)

Strange things happen in cross-language and second-language vowel perception: Nave non-native listeners have been reported to rely on acoustic properties which are nonfunctional in their L1 and dysfunctional for the perception of non-native vowels; naïve non-native listeners' perception is guided by a preference for vowels that are peripheral in the articulatory/acoustic vowel space; and, in general, naïve non-native listeners' perception is not well predicted by comparative analyses of vowels of the native and the non-native language. This presentation reviews the accented perception of vowels by focusing on two forces which shape non-native vowel perception: universal perceptual preferences which non-native listeners (and infants) bring to the task of vowel perception, and perceptual biases which non-native listeners transfer from their native to the non-native language. Strange and her colleagues have shown that these biases cannot be predicted from acoustic comparisons; rather, they have to be examined directly through assessments of the perceived cross-language similarity of vowels. This presentation addresses several of the still unresolved questions regarding the design and the interpretation of perceptual assimilation tasks used to account for the accented perception of vowels. [Work supported by Danish Research Council for the Humanities, Canadian Natural Sciences and Engineering Research Council.]

9:35

5aSWa2. Articulating the Perceptual Assimilation Model (PAM): Perceptual assimilation in relation to articulatory organs and their constriction gestures. Catherine T. Best (MARCS Auditory Labs, Univ. Western Sydney, Locked Bag 1797, Penrith NSW 1797, Australia, and Haskins Labs, 300 George St., New Haven, CT 06511, c.best@uws.edu.au), Louis Goldstein (Univ. Southern Calif., Los Angeles, CA 90089-1693), Michael D. Tyler (Univ. Western Sydney, Penrith NSW 1797, Australia), and Hosung Nam (Haskins Labs, New Haven, CT 06511)

A core premise of the Perceptual Assimilation Model of non-native speech perception (PAM) [Best (1995); Best & Tyler (2007)] is that adults perceive unfamiliar non-native phones in terms of articulatory similarities/dissimilarities to native phonemes and contrasts. The implied attunement to native speech emerges early: As infants begin to discern the articulatory organization of native speech, language-specific effects in non-native speech perception appear (≈6–10 months). Given that non-native phones, by definition, deviate phonetically from native ones, how can we characterize articulatory similarity in concrete, testable ways? The Articulatory Organ Hypothesis (AO) [Studdert-Kennedy & Goldstein (2003); Goldstein & Fowler (2003)] offers a possible approach, positing that infants decompose the oral-facial system into distinct articulatory organs (e.g., lips, tongue tip, tongue dorsum) and are sensitive to their actions in producing vocal tract constrictions. Thus, between-organ contrasts should be easily perceived/learned by infants and adults, whereas detection of within-organ contrasts must become attuned to the distribution of differing constriction locations/types by that organ in input speech. We discuss articulatory, attunement modeling, and perceptual evidence consistent with these predictions, and present a revised version of PAM that incorporates the AO Hypothesis and related principles of articulatory phonology [Browman & Goldstein (1991)]. [Work supported by NIH.]

Session 5aSWb

Speech Workshop: Research and Applications to Second Language (L2) Speech Perception

Susan G. Guion, Chair

Dept. of Linguistics, Univ. of Oregon, Eugene, OR 97403-1290

Invited Papers

10:30

5aSWb1. Accent and intelligibility from an applied perspective. Murray J. Munro (Dept. of Linguist., Simon Fraser Univ., 8888 University Dr. Burnaby, BC V5A 1S6, Canada)

Listeners are remarkably sensitive to non-native patterns of speech, whether they are presented with full sentence productions, or with very short or severely degraded speech, including noisy, filtered, and temporally disrupted utterances. Furthermore, even phonetically unsophisticated listeners can reliably scale accents. From the standpoint of second language (L2) users, speaking with a detectable accent has important social consequences. One is that L2 speech is sometimes less intelligible or may require listeners to allocate more processing resources than does native speech. However, evidence also indicates that some salient phonological markers of L2 status have little or no impact on listener comprehension. Distinguishing these from accent features that reduce intelligibility is a critical concern in language pedagogy. Another consequence noted in empirical research is that accent stereotyping and negative social evaluation of accented speakers are linked to discrimination in remuneration, employment, and services. They may also be implicated in the exploitation of L2 speakers through questionable claims about the value of "accent reduction." This synthesis of previous and new research findings highlights a number of issues concerning methodology and interpretation in L2 speech research that are relevant to language teaching and assessment, and to human rights litigation. [Research supported by SSHRC.]

11:05

5aSWb2. The role of linguistic experience in lexical recognition. Andrea Weber (Max Planck Inst. for Psycholinguistics, Wundtlaan 1, 6525 XD Nijmegen, The Netherlands, andrea.weber@mpi.nl)

Lexical recognition is typically slower in L2 than in L1. Part of the difficulty comes from a not precise enough processing of L2 phonemes. Consequently, L2 listeners fail to eliminate candidate words that L1 listeners can exclude from competing for recognition. For instance, the inability to distinguish /r/ from /l/ in *rocket* and *locker* makes for Japanese listeners both words possible candidates when hearing their onset (e.g., Cutler, Weber, and Otake, 2006). The L2 disadvantage can, however, be dispelled: For L2 listeners, but not L1 listeners, L2 speech from a non-native talker with the same language background is known to be as intelligible as L2 speech from a native talker (e.g., Bent and Bradlow, 2003). A reason for this may be that L2 listeners have ample experience with segmental deviations that are characteristic for their own accent. On this account, only phonemic deviations that are typical for the listeners' own accent will cause spurious lexical activation in L2 listening (e.g., English *magic* pronounced as *megic* for Dutch listeners). In this talk, I will present evidence from cross-modal priming studies with a variety of L2 listener groups, showing how the processing of phonemic deviations is accent-specific but withstands fine phonetic differences.

11:40

5aSWb3. Designing the foreign language learning environment: From basic research towards product development. Reiko Akahane-Yamada (ATR Learning Technol. Corp., 2-2-2, Hikaridai, Seika-cho, Soraku-gun, Kyoto, 619-0288, Japan, yamada@atr-lt.jp)

In order to examine the acquisition of English by native speakers of Japanese, a series of training studies were conducted under various environments, that is, in the laboratory, at schools, or in virtual spaces over the Internet, and learners of various ages participated. The results demonstrated that web-based training methods using computers can improve even adult learners' ability to perceive and produce L2, and that the acquisition of phonological categories plays an important role in the language learning. Based on these results, an L2 training system, dubbed ATR CALL BRIX, was developed by putting emphasis on speech learning. The system is a collection of training tools for speech perception, production, and comprehension. Each component focuses on the acoustic-phonetic, prosodic, lexical, or semantic decoding level of spoken language. Speech analysis and pronunciation evaluation tools are also provided. The target users vary from children to adults and from beginners to advanced learners. The content is designed with Learning Object concept and each component is adjustable on the learner characteristics and curricula. The system is already in the market. It is suggested that the cross-language and L2 acquisition studies are readily applicable to designing actual foreign language learning environment. [Work supported by JSPS.]

Session 5pSWa

Speech Workshop: Cross-Language Speech Perception and Linguistic Experience: Poster Session B

Rajka Smiljanic, Chair

Dept. of Linguistics, University of Texas at Austin, Austin, TX 78712-0198

Contributed Papers

All posters will be on display from 1:30 p.m. to 3:00 p.m. To allow contributors an opportunity to see other posters, contributors of odd-numbered papers will be at their posters from 1:30 p.m. to 2:15 p.m. and contributors of even-numbered papers will be at their posters from 2:15 p.m. to 3:00 p.m.

5pSWa1. Foreign accented speech: Energetic or informational masking?

Lauren Calandruccio, Christina Yuen, Sumitrajit Dhar (The Roxelyn and Richard Pepper Dept. of Commun. Sci. and Disord., Northwestern Univ., 2240 N. Campus Dr., Evanston, IL 60208, lauren.calandruccio@gmail.com), and Ann Bradlow (Northwestern Univ., Evanston, IL 60208)

Normal-hearing monolingual listeners whose native language is English experience a release from masking when the competing speech stimuli are spoken in a language other than English [e.g., K. J. Van Engen and A. R. Bradlow, *J. Acoust. Soc. Am.* **121**, 519 (2007)]. It is unclear whether this release is due to the fact that the masking speech is not spectrally matched to the target speech (energetic influence), or that listeners are unable to understand the masking speech and therefore find it less “distracting” when spoken in a non-native language (informational influence). This study investigates listeners’ recognition of English speech presented in the presence of a continuum of five two-talker babble maskers. The two-talker maskers (all created using male voices) include English babble, Mandarin-accented English babble with high intelligibility, Mandarin-accented English babble with moderate intelligibility, Mandarin-accented English babble with low intelligibility, and Mandarin babble. We hypothesize that, due to increased informational masking across the accented English continuum (from unaccented to heavily accented) in the masker speech, we will observe an increase in the target English speech intelligibility. These data will provide insight into the balance of energetic and informational influences on the release in masking observed for monolingual listeners when listening to English in a noncompeting masker language.

5pSWa2. Perceptual training really matters: evidence of a study with English as a foreign language (EFL) vowels.

Denize Nobre-Oliveira (Federal Ctr. of Technolog. Education of Santa Catarina, Av. Mauro Ramos 950, Florianopolis, SC, Brazil, 88020-300, denizenobre@yahoo.com.br) and Andreia S. Rauber (Univ. of Minho, Campus de Gualtar, Braga, Portugal 4715-057)

This study aimed at: (i) investigating the perception of English vowels by Brazilian English as a foreign language (EFL) highly proficient speakers, and, based on the findings; (ii) designing and testing perceptual training tasks that could possibly minimize perception difficulties by EFL learners. Two experiments were conducted. Experiment 1 tested vowel perception by means of an identification test elaborated with synthetic stimuli. The results showed that the vowels most often misidentified were /i/, /I/, /E/, /æ/, /U/, and /u/, and that duration does not seem to play a role on the perception of each vowel, suggesting that participants rely primarily on spectral cues. Experiment 2 then tested the effect of perceptual training of the difficult vowels by means of exposure to both natural and synthetic stimuli (with spectral manipulation). The training on these vowels was given over a 3-week period to 29 Brazilian EFL learners, which were divided into the natural stimuli (NatS) group and the synthesized stimuli (SynS) group. The results show that: (i) both experimental groups improved significantly after training; (ii) there was more improvement in the SynS group than in the NatS group; and (iii) knowledge acquired with artificially enhanced stimuli was transferred to

stimuli produced naturally. [Work supported by CAPES (Committee For Postgraduate Courses in Higher Education, Brazilian Ministry of Education) grants to both authors.]

5pSWa3. Perception of Arabic and Japanese vowel length contrasts by native versus non-native Japanese listeners. Kimiko Tsukada (Dept. of Int. Studies, Macquarie Univ., NSW 2109, Australia ktsukada@mq.edu.au) and Yukari Hirata (Colgate Univ., Hamilton, NY 13346)

The perception of short versus long vowel contrasts in Arabic and Japanese was examined for native Japanese [(NJ), $n=5$] and non-native Japanese [(NNJ), $n=5$] listeners. The length contrast is phonemic in both languages. The question addressed was whether experience with Japanese helps NNJs to process the length contrast in Arabic. The listeners’ discrimination accuracy was assessed in an AXB test. The stimuli were CV₁C words in Arabic and CV₁CV words in Japanese (where V₁ was either short or long). As expected, NJs were more accurate than NNJs in discriminating the Japanese contrast. While NJs made more errors in Arabic than Japanese, NNJs showed a similar level of discrimination accuracy for the two languages. Finally, the number of errors for the Arabic stimuli was comparable for NJs and NNJs. Thus, the between-group difference existed for the Japanese but not for the Arabic contrast. The possibility that familiarity with phonetic characteristics of a recently acquired language may influence the processing of sounds in an unknown language with similar characteristics to the target language will be discussed. Native Arabic perception is currently under investigation. [Work supported by Macquarie University New Staff grant.]

5pSWa4. Perception of English voiceless alveolar and postalveolar fricatives by Korean speakers. Yunju Suh (Dept. of Linguist., Stony Brook Univ., Stony Brook, NY 11794, yunjusuh@gmail.com)

Korean lacks place contrast of coronal fricatives before i. Yet three alveopalatal fricatives, fortis, lenis, and labialized, occur in this context. Fortis and lenis alveopalatals are intermediate between English alveolar and postalveolar in spectral peak location, though fortis has peak at higher frequencies, and thus is closer to English s. Peak location of labialized alveopalatal is the lowest, largely overlapping with that of English j. The presence of L1 contrast among alveopalatals seems to facilitate Korean listeners’ perception of English si-ji contrast, especially that between plain and labialized alveopalatals. Korean listeners were presented with eight-step continuum of English si (step 1) to ji (step 8), and asked to identify them with an L1 category. The percentage of fortis answer gradually decreased from steps 1 to 4, as lenis answer gradually increased. Labialized answer appeared below 3% until step 4, and increased above 68% at step 5, indicating categorical change of the percept from plain to labialized alveopalatals. There was no categorical change from fortis to lenis, presumably because Korean fortis-lenis contrast involves complex acoustic cues such as vowel f0, frication duration, and amplitude difference between harmonics, in addition to frication noise frequency.

5pSWa5. Electrophysiological indices of vowel discrimination in late bilinguals. Carol A. Tessel, Arild Hestvik, Dolores Girbau, Richard G. Schwartz, and Valerie L. Shafer (The Graduate Ctr.-CUNY, 365 5th Ave., Speech and Hearing-7th floor, New York, NY 10016, ctessel@gc.cuny.edu)

The purposes of the current study are: (1) To investigate discrimination of a vowel contrast not found in Spanish by late learners of English with Spanish as a first language; (2) to assess whether the use of natural consonant-vowel-consonant stimuli and multiple exemplars will show the same pattern of results as found in studies using synthetic stimuli; and (3) examine whether better speech perception as examined by the event-related potential, mismatch negativity (MMN) correlates with greater language usage as measured by a language background questionnaire. The results indicate that late-bilinguals are slower at discriminating the vowel contrast than the English monolinguals, as indexed by MMN. Monolingual English listeners showed significant MMN from 200 to 300 ms, whereas for late learners of English, the MMN was significant 50 ms later between 250 and 300 ms. Both groups showed excellent behavioral discrimination of the vowel contrast. Results also suggest that vowel category reshaping is less flexible in adult learners of a second language. The results will be discussed in relation to language usage.

5pSWa6. Allophonic alternations influence non-native perception of stress. Christine E. Shea and Suzanne Curtin (Dept. of Linguist., Univ. of Calgary, 2500 University Dr. NW, Calgary, AB T2K 0N4, Canada)

We examined the identification of stressed syllables by adult L2 Spanish learners to see if it is influenced by an allophonic alternation driven by word position and stress. We utilized the Spanish voiced stop-approximant alternation, where stops occur in word onsets and stressed-syllable onsets. If L2 learners track the distribution of this alternation, they should link stops to stressed syllables in word onset position and approximants to unstressed, word medial position. Low- and Intermediate-level L1 English/L2 Spanish learners, Native Spanish and monolingual English speakers listened to a series of CVCV nonce words and determined which syllable they perceived as stressed. In Experiment 1, we crossed onset allophone and vowel stress. In Experiment 2, we alternated the onset allophone and held the vowel steady. Our results show that less experienced groups were more likely to perceive stressed vowels and approximant onset syllables as stressed. This suggests that learning the interplay between allophonic distributions and their conditioning factors is possible with experience. L2 learners track distributions in the input and this, in turn, influences their perception of other properties in the language, in this case, syllable stress. Native language distributions and target language proficiency play a role in this process.

5pSWa7. Lexical encoding of the second language vowel length contrasts. Jeong-Im Han (Dept. of English, Univ. of Konkuk, Hwayang-dong 1, Gwangjin-gu, Seoul, 143-701, Korea, jhan@konkuk.ac.kr)

Given the previous results for the L2 learners' processing difficulties of suprasegmentals as compared to segmentals, this study tests whether L2 late learners lack a proper phonological representation of suprasegmentals they could use to encode those contrasts. In Experiment 1, two groups of Korean late learners of Japanese (beginner versus advanced) as well as Japanese controls took a simple AX discrimination of the nonword pairs that varied in vowel length only, and showed that both groups of Korean learners had no difficulty to perceive the acoustic differences of the long versus short vowels in Japanese. However, in Experiment 2, when the same groups of learners participated in a more demanding lexical decision task using word-nonword pairs with vowel length differences, they had much difficulty in the use of such vowel length to access the lexicon. Even though there was significant improvement between the beginner and the advanced groups, there were still significant differences between the advanced group and the Japanese natives. These results suggest that L2 late learners might have a true processing deficits for suprasegmental properties in their phonological representation which were not in their L1, which cannot be easily eliminated with a significant exposure to L2.

5pSWa8. Perception of complex word-initial onsets in English by native speakers of Japanese. Miekko Sperbeck (Dept. of Linguist., City Univ. of New York, the Graduate Ctr., 365 Fifth Ave., New York, NY 10016, msperbeck@gc.cuny.edu)

Past studies have shown that English L2 learners whose native languages have relatively simple syllable structure have different degrees of difficulty in producing complex syllable and word onsets in English. For instance, more marked clusters (e.g., /bj/) were harder to produce than the less marked ones (e.g., /pj/) for Japanese learners of English [E. Broselow and D.

Finer, *Second Language Research* 7, 35–59 (1991)]. However, what is unknown is whether such difficulties reflect problems in perceiving complex syllable structures. The current study tested Japanese L2 learners and American English controls in a categorical ABX discrimination test of eight contrasts between nonsense words with consonant cluster onsets CC(C)VCV versus CaC(C)VCV sequences (e.g., /spani/versus/səpani/) and included /sp, sk, pl, bl, kl, gl, spl, skl/ clusters. Words were imbedded in short sentences to increase task difficulty. Results showed that overall accuracy by the Japanese group was significantly poorer than for the Americans (72% and 98% correct respectively). Certain clusters were harder for Japanese listeners (e.g., 76% correct for /pl/ but 64% for /bl/). Productions of the words were also obtained and are related to perceptual performance.

5pSWa9. Discrimination of Mandarin disyllabic tone contrasts by American English-speaking adults and children. Shari Berkowitz (CUNY Graduate Ctr., Speech Acoust. and Percept. Lab., 365 Fifth Ave., New York, NY, 10016, shariellen@gmail.com)

Most research on cross-language perception of Mandarin tones has used monosyllabic stimuli, despite the fact that Mandarin words are predominantly disyllabic. Previous work on disyllable discrimination (Berkowitz and Strange, 2007) suggested that perception by English-speaking adults is influenced by coarticulation and context effects. In this series of studies, subsets of stimuli were chosen to attempt to isolate the effects of fundamental frequency height, contour, turning point and timing on English speakers' ability to perform a same/different task. Three balanced blocks of approximately 10 min each were given, to keep the task appropriate for preschoolers. Feedback conditions varied; some subjects received feedback throughout and others on the first block only. Early results suggest that discrimination of disyllabic Mandarin stimuli is easier for American English speakers if the differences between disyllables occur at onset or offset of the complete utterance; differences in the middle pose more of a challenge. Subjects appear to evaluate disyllabic contours as a whole, rather than on a syllable-by-syllable basis. Implications for future research and training protocols will be discussed.

5pSWa10. Factors inducing cross-linguistic perception of illusory vowels. Jiwon Hwang (Dept. of Linguist., Stony Brook Univ., Stony Brook, NY 11794-4376, jihwang@ic.sunysb.edu)

Japanese speakers tended to hear an illusory vowel in illegal consonant sequences (Dupoux *et al.*, 1999). Korean has no sequences of stop followed by nasal; therefore, it is expected that Korean speakers would perceive an illusory vowel in stop-nasal. In an identification task comparing Korean and English listeners on stimuli along a continuum that ranged from no vowel (igna/ikna) to a full vowel (igVna/ikVna), Korean listeners reported the presence of a vowel significantly more often than English listeners, even when there is no vowel in the stimuli. However, this effect was found only when the stop was voiced, even though [kn] and [gn] are both illegal Korean sequences. In an ABX discrimination task, Korean participants had more difficulty discriminating 'stop-nasal' from 'stop-V-nasal' than English participants, again only when the stop was voiced. The results suggest that voicing, rather than simple illegality, induces bias toward perception of illusory vowel in Korean. This is explained by the fact that in Korean, voiced stops occur only prevocally in intersonorant position (as an allophone of voiceless obstruents). This voicing effect is reflected in Korean L2 learners' production patterns in which they insert a vowel more often in voiced stop-nasal sequences than in voiceless stop-nasal sequences. [Work supported by NSF BCS-07460227.]

5pSWa11. Individual differences in the perception of final consonant voicing among native and non-native speakers of English. Bruce L. Smith (Dept. of Commun. Sci. and Disord., Univ. of Utah, 390 S. 1530 E., Rm. 1201, Salt Lake City, UT 84112, bruce.smith@hsc.utah.edu) and Rachel Hayes-Harb (Univ. of Utah, Salt Lake City, UT 84112)

Various studies have provided modest evidence supporting the ideas: (1) that non-native listeners outperform native listeners in judging productions by other non-native speakers with whom they share a first-language (L1) background and (2) that non-native listeners are more accurate judging productions by subjects with whom they share an L1 background than they are judging speech contrasts of native English speakers. Research regarding these issues has typically been based on group findings, so it is not clear to

what extent these tendencies may occur among individual listeners. The present investigation reports findings for 15 native English (NE) listeners and 15 non-native listeners (native Mandarin: NM), who made judgments about English voiced/voiceless minimal pairs produced by six other NE and six other NM talkers. When listening to the six NM talkers, fewer than half of the 15 NM subjects performed better than the range shown by the 15 NE listeners. Further, the 15 NM listeners were more accurate than the 15 NE listeners in judging the voicing contrast for just two of the six NM speakers. Thus, limited evidence was found that individual, non-native subjects demonstrate patterns that might have been expected on the basis of previous group findings.

5pSWa12. Perceptual confusions of American English vowels and consonants in Arabic-English bilinguals. Valeriy Shafiro (Dept. Comm. Disord. Sci. Rush Univ. Medical Ctr., 600 S. Paulina Str., 1015 AAC, Chicago, IL 60612), Anatoliy Kharkhurin (American Univ. of Sharjah, Sharjah, UAE), and Erika Levy (Columbia Univ., New York, NY 10027)

This study investigated the perception of American English (AE) vowels and consonants by proficient adult Arabic-English bilinguals studying in the United Arab Emirates (UAE). The native language of all participants was Arabic, and their average age of English acquisition was 6 years. In a closed set format, 29 participants were asked to identify 12 AE vowels presented in /hVd/ context and 20 AE consonants in three vocalic contexts: /aCa/, /iCi/, and /uCu/. Overall vowel identification was 70% correct. The three least-accurately identified vowels were /a/, /ɔ/, /æ/, which were 17%, 38%, and 54% correct, respectively. Most confusions were found among low and back vowels. Overall, perception of consonants was more than 90% correct in all three vocalic contexts. The most errors on consonants were found for /ð/, i.e., 63% and 46% correct in /aCa/ and /iCi/ contexts, respectively. In both contexts, /ð/ was most frequently confused with /v/. However, identification of /ð/ in /uCu/ context was far more accurate; i.e., 97% correct. These results suggest a phonetic context effect on the cross-language perception of consonants.

5pSWa13. Experience with foreign accent influences non-native (L2) word recognition: The case of th-substitutions. Adriana Hanulikova and Andrea Weber (Max Planck Inst. for Psycholinguistics, Nijmegen, The Netherlands)

Effects of mispronunciations on word recognition are often explained in terms of perceptual similarity: the less similar mispronunciations are to target words, the more lexical activation is disturbed. Using th-mispronunciations that occur in foreign-accented English, this study investigated whether, irrespective of perceptual similarity, experience with mispronunciations influences word recognition. While Dutch speakers of English frequently substitute voiceless *th* with /t/ (e.g., /teft/ for *theft*), German speakers prefer /s/ (e.g., /seft/); the perceptually close /f/ occurs infrequently in both groups. Four eye-tracking experiments examined whether familiar substitutions cause stronger lexical activation than less familiar ones. German and Dutch participants listened to sentences spoken with a German or Dutch accent (e.g., "Now you will hear /teft/"), while they were looking at a display with four printed words (e.g., *theft*, *left*, *kiss*, *mask*). The time course of lexical activation was measured as a function of amount of looks to printed th-words after hearing mispronounced words with a /t/, /s/, or /f/ substitute. Irrespective of the heard accent, th-words were fixated more often when hearing /t/ for Dutch listeners but /s/ for German listeners, while /f/ never outperformed the accent-specific dominant substitute. The results suggest an influence of accent-specific experience on L2 word recognition.

5pSWa14. Cross-linguistic evidence for the influence of native language prosody in infant speech segmentation. Suzanne Curtin (Depts. of Psych. and Linguist., Univ. of Calgary, 2500 University Dr. NW, Calgary, AB T2N 1N4, Canada, scurtin@ucalgary.ca), Linda Polka, Shani Abada (McGill Univ., Montreal, QC H3G 1A8, Canada), and Reaper Sally-Joy (Univ. of Alberta, Alberta, Canada)

Research using artificial languages with English-learning infants has shown both prosodic and distributional cues are used for speech segmentation by 7 months. When these cues conflict, infants younger than 7 months rely on distributional cues while older infants rely on prosodic cues). In the present study we assessed the role of prosodic information in segmentation when it is not favorably aligned with distributional cues, to determine

whether language-specific rhythmic biases guide segmentation as suggested by studies using natural speech. Two continuous streams of naturally produced syllables (English and French) were constructed using nine syllables that are permissible in both languages. Within each stream statistical cues were manipulated independently of language-appropriate stress cues. English- and French-learning 8-month-olds were familiarized with their native language stream and then present test probe strings to determine what syllable sequences were extracted from the stream. Probes were selected to assess the role of stress cues in segmentation. Findings show that English infants make use of a trochaic template; Canadian-French infants show a weaker and less focused reliance on stress cues to segment words from connected speech. These cross-linguistic differences reflect processing biases that may be set by language experience and/or elicited by speech input properties.

5pSWa15. Individual gains from auditory training of English vowels for Greek native speakers. A. Lengeris (Dept. of Speech Hearing and Phonetic Sci., Univ. College London, 2 Wakefield St., London WC1N 1PF, UK, a.lengeris@ucl.ac.uk)

Several studies have shown that high-variability auditory training can improve the perception of second-language (L2) sounds by adult learners. However, even when testing a homogenous L2 group, considerable differences are commonly found between individuals not only in pre-training performance but also in how each trainee responds to training. Additionally, it is not clear what aspects of perceptual processing are actually being trained. To address these issues the present study trained Greek native speakers in perceiving the vowels of Southern British English. The trainees received five sessions of high-variability auditory training (including multiple words spoken by multiple talkers). The pre- and post-training tests included identification and discrimination tasks in L1 (Greek) and L2 (English), and a nonspeech (F2 only) discrimination task. Preliminary results show significant improvement in the trainees' identification of L2 vowels, but no significant change in their L2 discrimination. The relationships between pre-training L1, L2, and nonspeech performance and gains in L2 identification for individuals will be discussed.

5pSWa16. Vowel quantity and quality perception in Finnish and Estonian speakers. Stefan Werner (General Linguist. and Lang. Technol., Univ. of Joensuu, Finland, stefan.werner@joensuu.fi) and Einar Meister (Tallinn Univ. of Technol., Estonia)

Vowel quality perception in quantity languages might be expected to be unrelated to duration of the vowels since duration is used to realize phonemic duration oppositions. Our studies, both earlier reported ones and our latest project, indicate, though, that vowel-intrinsic duration changes have a consistent effect on vowel identification in Estonian and Finnish speakers. Our latest experimental setup for investigating perceptual effects of microduration consists of two blocks, first a set of tests to identify the subject's formant-based categorial boundaries between vowel pairs on the close-open axis, then the accordingly selected listening tests presenting formant-wise ambiguous vowel exemplars produced with varying durations. Results from ten Estonian and ten Finnish speakers will be presented. In addition, the phenomenon observed will be compared with formant structure and duration perception in languages where these parameters co-vary (e.g., English) and thus an influence of sub-phonemic durational changes on vowel perception would seem much likelier.

5pSWa17. The phonotactic influence on the perception of a consonant cluster /pt/ by native-English and native-Polish listeners: A behavioral and ERP study. Monica Wagner and Valerie L. Shafer (Ph.D. Prog. in Speech-Lang.-Hearing Sci. The Graduate Ctr., 365 Fifth Ave., New York, NY 10016-4309, mpwsp1@aol.com)

The perception of the cluster /pt/ in word onset in native-Polish and native-English adult listeners was compared using behavioral and event-related potential (ERP) measures to explore the language-specific phonotactic influence on speech perception. Acoustic-phonetic features of phonemes vary with context and phonotactic rules specify all allowable phoneme contexts. Both native-Polish and native-English groups are exposed to the cluster /pt/ in their language but only one group, native-Polish, experience the cluster in the context examined, word onset. Word onset consonant cluster /st/ is used as a control. Participants were asked to determine whether

they heard the second word of a pair as consisting of two syllables or three (e.g., pteva versus peteva). Behavioral results revealed that Polish listeners perceive the /pt/ cluster with greater accuracy than English listeners. ERPs revealed late components that differ for the two language groups reflecting linguistically-relevant aspects of the /pt/ contrast and early components that are essentially the same in the two language groups reflecting physical-acoustic differences. ERP results suggest the /st/ contrast to be more salient than the /pt/ contrast consistent with the higher behavioral accuracy for the /st/ cluster. These findings support the suggestion that psychoacoustic salience of acoustic-phonetic features influences speech perception.

5pSWa18. The roles of second-language experience and accent in speech recognition in noise. Melanie Preece-Pinet and Paul Iverson (UCL, Dept. of Lang. Sci., Chandler House, 2 Wakefield St., London WC1N 1PF, UK, m.pinet@ucl.ac.uk)

Previous work has demonstrated that there is an interaction between native (L1) and non-native (L2) accents in speech recognition in noise, with listeners being better at L1 or L2 accents that match their own speech. This study investigated how L2 experience modulates this talker-listener interaction. L1 southern British English (SE) and L1 French listeners with varying L2 English experience (inexperienced FI, experienced FE, and bilinguals FB) were tested on the recognition of English sentences mixed in speech-shaped noise that was spoken with a range of accents (SE, FE, FI, Northern Irish, and Korean-accented English). The results demonstrated that FI listeners were more accurate with strongly accented FI talkers, and were progressively worse for the other accents, perhaps based on accent similarity. The SE listeners, however, had a strong advantage for SE speech, but were similarly poor at understanding the other accents. Their recognition processes were thus selectively tuned to their own accent, rather than having the graded sensitivity of FI listeners. FE and FB listeners were more similar to SE listeners as their experience with English increased. The results thus suggest that increased exposure to L1 speech changes both the intelligibility of accents and the selectivity of accent processing.

5pSWa19. Second language word segmentation in a fluent speech listening task. Tuuli M. Adams (Dept. of Linguist., New York Univ., 726 Broadway, New York, NY 10003, tuuli.adams@nyu.edu)

Extracting words from a continuous speech stream is a complex task involving the integration of multiple linguistic cues. Like infants, adults have been shown to use both distributional information through statistical learning, and metrical and intonational information, when segmenting words in a second language. This study investigates adults' native language influence on speech segmentation, and the extent to which linguistic knowledge is augmented by exposure to fluent, natural speech in a second language. In the experiment, English listeners completed a word learning task in an unfamiliar language, Finnish. Next, they listened to a fluent speech passage which contained learned words, as well as syllable sequences controlled for the same frequencies and transitional probabilities as the real words. English speakers have been shown to use acoustic stress cues to locate word boundaries, and while Finnish has a regular stress pattern, other phonotactic patterns could affect English listeners' segmentation abilities. Afterwards, they completed a forced-choice identification task, choosing from pairs of real and non-words, including incorrectly segmented syllable sequences, to identify the token which is more likely a word in Finnish. The behavioral data are analyzed for patterns reflecting the integration of native language linguistic knowledge and statistical learning abilities.

5pSWa20. Assessing the contribution of second language experience and age of learning in Catalan/Spanish bilinguals' perception and production of English sounds. Natalia Fullana and Ian R. A. MacKay (Dept. of Linguistics, Univ. of Ottawa, 70 Laurier Ave. East, Ottawa ON, K1N 6N5 Canada, fullnat@gmail.com)

Previous research in immersion settings has shown that an early age of onset of second language (L2) learning, together with long-term exposure to the L2, are determinant factors for perceiving and producing L2 sounds accurately [e.g., Flege, MacKay, & Meador (1999)]. However, research in formal learning contexts has resulted in negative evidence for an early age of learning advantage [e.g., Garcia-Lecumberri & Gallardo (2003)] or in divergent experience effects (Cebrian, 2003, 2006). This study aimed to further examine the contribution of the factors of age of onset of L2 learning (AOL)

and experience in a foreign language learning environment. Catalan/Spanish bilinguals studying English at university, with AOLs of 4 to 14 years and a minimum of 7 years of formal instruction, performed an AXB discrimination task, a picture narrative, and a delayed sentence repetition task. Results revealed that Catalan/Spanish bilinguals with somewhat longer exposure to English and an earlier AOL tended to discern English sounds at higher correct rates. By contrast, a great degree of variability was found across the bilinguals' extemporaneous and prompted production of English segments. Findings are discussed in terms of current models of L2 speech acquisition and their application to formal learning settings. [Work supported by post-doctoral fellowship from the Ministerio de Educacion y Ciencia and the FE-CYT (Spain).]

5pSWa21. Asymmetric development of perception and production of lexical stress in Korean second-language (L2) learners of English. Jeonghwa Shin and Shari R. Speer (Dept. of Linguist., Ohio State Univ., 1712 Neil Ave., Columbus, Ohio 43210, jshin@ling.osu.edu)

This study explores perception and production of lexical stress information in L2 English learners whose L1 employs a fixed rhythmic pattern at the lexical level. Nineteen English L1 speakers and 14 Korean L2 learners of English were trained to learn 16 minimal stress nonword pairs with picture referents which are segmentally disambiguating in the last syllable (/dʒákunai/ vs /dʒakúnə/). The eye-tracking perception experiment revealed that English L1 speakers exploited lexical stress information of the first two syllables to spot the target word in the instruction, "Click on the (target word)," whereas Korean L2 learners' identification of the target word was delayed until the last syllable. In their production of words in a carrier, "This is the (target word)," however, L2 learners used loudness and durational cue to indicate alternative prominence of the first two syllable as did English L1 speakers. These results imply the development of production and processing of lexical stress in L2 word learning can be asymmetrical. This asymmetry is attributable to the L1 which has a fixed (T)HLH accentual phrase pattern at the lexical level and thus provides little incentive for the lexically specified stress processing. [Work supported by Linguistics Dept., Ohio State University.]

5pSWa22. Do first-language (L1) phonemic categories play a role in the perception of second-language (L2) phonemic contrasts? A look from the perception of Cantonese codas by Mandarin speakers. Patrick Chun Kau Chu (School of Psych., The Univ. of New South Wales, Sydney, Australia and Dept. of Linguist. and Modern Lang., The Chinese Univ. of Hong Kong, Hong Kong, China, patrickhk83@hotmail.com)

This study investigated whether the phonological system of L1 or universal hierarchy of perceptual similarities has a larger effect on Mandarin speakers' perception of Cantonese phonemic categories. In Mandarin and Cantonese, there are differences in the distribution of nasals and plosives in the coda position. Both nasals (/m/, /n/, and /ŋ/) and plosives (/p/, /t/, and /k/) are possible codas in Cantonese while only nasals (/n/ and /ŋ/) can appear in the coda position in Mandarin. Non-native phonemic categories (e.g., /t/) will be assimilated to a native phonemic category (e.g., /n/) if L1 plays a larger role while assimilation to a non-native phonemic category (e.g., /p/ or /k/) may support the idea that universal hierarchy of perceptual similarities plays a more important role. An AX discrimination task is carried out to see whether Mandarin and Cantonese speakers can discriminate these six phonemic contrasts in Cantonese monosyllabic words. Results showed that Mandarin speakers have poorer discrimination ability in the later type (e.g., /t/ vs /k/) than the former type (e.g., /t/ vs /n/). This suggests that the Perceptual Assimilation Model may need to take universal hierarchies of perceptual similarities into account when predicting L2 learners' discrimination ability in a second language.

5pSWa23. Implicit learning of non-native speech stimuli. Eleni L. Vlahou, Athanassios Protopapas (ILSP/Athena, Artemidos 6 & Epidavrou, GR-151 25 Maroussi, Greece, evlahou@ilsp.gr), and Aaron Seitz (Univ. of California-Riverside, Riverside, CA 92521)

Previous studies have induced robust adult learning of non-native natural speech stimuli using explicit instructions and feedback. Here, Greek adults were exposed to non-native Hindi phonemes for six sessions in which they were unaware of the phoneme distinctions and the phonemes had no relevance to their main task. Stimuli were natural recordings of CV syllables (a

retroflex or dental unvoiced stop followed by [a]) from a Hindi speaker. On each trial, participants heard two identical dental sounds and two retroflex sounds differing in intensity by an adaptively varied amount between 0.5–3 dB. The explicit task was to identify which pair differed in intensity, while the implicit learning goal was the phonetic contrast. After training, participants were tested on explicit phonetic identification and discrimination of trained and untrained stimuli spoken by the same and a novel speaker. The trained group outperformed an untrained group who were administered the same tests. Our results are compatible with a perceptual learning model where task-irrelevant stimuli (Hindi sounds) are learned due to a systematic pairing with task targets (intensity difference). Learning did not extend to the novel speaker, in agreement with previous studies showing that variability in training is crucial for generalization.

5pSWa24. Duration as a phonetic cue in the categorization of /i:/-/ɪ/ and /s/-/z/ by Spanish/Catalan learners of English. Eva Cerviño and Joan C. Mora (Dept. Filologia Anglesa, Universitat de Barcelona, Gran Via 585, 08007-Barcelona, Spain, ecervino@ub.edu)

Previous research has shown that Spanish/Catalan learners of English (SCLs) rely on duration rather than spectral cues in the categorization of contrastive English vowel pairs such as /i:/-/ɪ/, despite length being nondistinctive in Spanish/Catalan. Native English speakers (NESs) rely more heavily on V-C duration ratio than on glottal pulsing in the perception of voicing contrasts in -VC contexts. This study investigated whether SCLs' overreliance on duration in vowel categorization also applied to consonants in contexts (-VC) where lack of closure voicing makes duration the main cue to voicing for NESs. SCLs ($N=40$) and NESs ($N=15$) participated in two lexical decision tasks consisting of /f/+V+/t/ stimuli drawn from two 8-step continua with shortened (/i:/) and lengthened (/ɪ/) vowels; and /p/+ /i:/+C stimuli drawn from six 8-step continua with simultaneously and independently modified vowels and final consonants (/i:/-/ɪ:/z/). Manipulating duration had a significant effect on SCLs' categorization of /i:/ and /ɪ/, but not on SCLs' categorization of /s/ and /z/, suggesting that SCLs made use of duration as a cue to vowel categorization, but did not use duration as a cue to voicing. These results are interpreted and further discussed in light of Bohn's Desensitization Hypothesis and McAllister's Feature Hypothesis.

5pSWa25. Phonetic cue-weighting in the acquisition of a second language: Evidence from Greek speakers of English. Anastasia Giannakopoulou, Maria Uther (Ctr. for Cognition and Neuroimaging, Dept. of Psychol., Brunel Univ., Uxbridge, Middlesex, UB8 3PH, UK), and Sari Ylinen (Univ. of Helsinki, PL 9, Helsinki, 00014, Finland)

The most difficult speech-sound contrasts for foreign-language learners are often the ones that have multiple phonetic cues, especially if the cues are weighted differently in the foreign and native languages. Greek speakers of English were studied to determine on what basis they are making discrimination and identification between English vowels. The use of spectral and duration cues of English vowel minimal pairs (e.g., "beat" versus "bit") in Greek speakers were studied using perception and discrimination tasks. There were two forms of perceptual, minimal pair identification tasks. One used natural stimuli and the other used matched vowel duration words to "force" the use of spectral cues. Performance was impaired for Greek speakers across both perceptual identification tasks compared to native speakers. But performance was the worst for Greek speakers for the matched duration condition. Interestingly, an AB-X discrimination task with the same stimuli did not hamper the performance of the Greeks compared to the English in the same way. Pilot data from Greek children also showed similar patterns of performance across conditions to the Greek adults, but with a somewhat reduced ceiling. These results are discussed in terms of the strategies used to acquire new languages.

5pSWa26. Role of rhythmic and intonational cues in language discrimination. Chad Vicens and Megha Sundara (Dept. of Linguist., 3125 Campbell Hall, UCLA, Los Angeles, CA 90095)

Languages differ in rhythm as well as intonation. Research indicates that adult listeners are able to use rhythm to discriminate between two languages from different rhythm classes [Ramus Mehler, (1999)]. For languages within the same rhythm class, adults are able to use intonation to discriminate between languages like English and Dutch, but only when one of the languages is familiar [Ramus and Mehler, (1999); Pijper, (1983)]. It remains

unclear if the rhythmic differences between languages in the same rhythm class are enough to support language discrimination. In this paper, we tested American English listeners' ability to categorize re-synthesized American English and German sentences or American and Australian English sentences from which all segmental information had been removed. English and German are from the same rhythm class and differ in intonation; whereas American and Australian English can be thought to be rhythmically identical, but differ in intonation. Subjects were tested in three conditions: (a) with only intonational cues; (b) with only rhythmic cues; and (c) both intonational and rhythmic cues. Preliminary results indicate that listeners rely on rhythm, but not intonation, to distinguish between English and German, and only on intonation to distinguish between American and Australian English.

5pSWa27. Discrimination of American vowels in disyllables mixed in speech babble by experienced Japanese and Russian learners of English. Kikuyo Ito, Yana, D. Gilichinskaya, and Winifred Strange (Speech Acoust. and Percept. Lab., CUNY-Graduate Ctr., 365 Fifth Ave., New York, NY, 10016-4309, kikuyoito@hotmail.com)

Previous studies in this laboratory examining speeded discrimination of American English (AE) vowels in quiet by Japanese (JP) and Russian (RU) late L2 learners indicated differences in relative difficulty of non-native contrasts that were predictable from L1 phonological differences. Response latencies were a sensitive measure of continuing L2 perceptual difficulties. In the present study, the same task (a speeded categorical ABX task with disyllabic stimuli) was administered to Japanese and Russian listeners, with stimuli mixed in speech babble at three levels (SNR 0, 6, 12). Eight experimental contrasts (four with spectral plus duration differences and four with spectral differences only) and four control contrasts were tested in lists with both vowel contrast and noise level varying randomly. Results indicated that both L2 groups performed more poorly than native AE control subjects on many of the experimental contrasts, including those differentiated by duration as well as spectral differences. Again differences in relative perceptual difficulty across L2 groups emerged. Perceptual assimilation patterns and performance on a test of English fluency and pronunciation (versant) were correlated with discrimination performance across individuals. [Work supported by NSF.]

5pSWa28. Phonetic accommodation in conversations between native and non-native speakers. Midam Kim (Linguist., Northwestern Univ., 2016 Sheridan Rd., Evanston, IL 60208, midamkim@gmail.com)

We explored phonetic accommodation during native speaker interactions (four native English pairs and four native Korean pairs) and native-non-native interactions (four native-non-native pairs, all speaking English). Speakers engaged in a collaborative picture description task that lasted approximately 20 min. Utterances from relatively early and late in the task were subsequently presented to native English listeners (or Korean listeners, for the Korean-language dialogues), who were asked to carry out XAB similarity judgments, where X=one talker's utterance and A/B=early and late utterances from the partner. Phonetic accommodation is indexed by how frequently listeners select the "late" utterance as sounding more similar to the target utterance. An independent group of native English speakers rated the nonnative utterances for degree of accentedness. Phonetic convergence was observed for native-native conversations (English or Korean), and this was stronger when speakers shared the same or similar dialects. In native-non-native conversations, none of the native speakers converged towards a non-native partner, while non-native speakers showed different patterns depending on their proficiency, with greatest convergence for moderately accented nonnatives. The results suggest that phonetic accommodation can occur cross-linguistically, and that it may be constrained both by speakers' dialect and by their language proficiency.

5pSWa29. Speeded discrimination of American English vowel contrasts by Spanish-speaking late second-language (L2) learners. Jason Rosas, Arsenia Barias, Yana D. Gilichinskaya, and Winifred Strange (Speech Acoust. and Percept. Lab., CUNY-Graduate Ctr., 365 Fifth Ave., New York, NY 10016-4309)

This study is the third in a series exploring discrimination of American English (AE) vowel contrasts by late L2-learners of English whose native languages have small vowel inventories (Japanese, Russian, Spanish). On a speeded ABX task, adult Spanish-speaking listeners discriminated multiple

AE vowel contrasts including adjacent height pairs that differed in both spectral and duration parameters, front/back pairs (differing only in spectral characteristics, and four nonadjacent control pairs). It was hypothesized that Spanish listeners, who do not distinguish native vowels based on duration, would have difficulties with both types of experimental contrasts, relative to control pairs. Additionally, mean reaction time (RT) difference scores (relative to mean RTs for control pairs) for Spanish listeners were expected to be slower than for AE controls. Preliminary findings confirm these predictions. Differences in relative difficulty of experimental pairs compared with earlier data for Japanese and Russian L2-learners showed L1-specific patterns of performance that were related to L1/L2 perceptual similarity patterns. Spanish subjects also completed the Versant Test, an English language proficiency examination conducted by phone. A correlational analysis of discrimination accuracy and speed with Versant Test fluency and pronunciation measures will be presented. [Work supported by NSF.]

5pSWa30. Spoken word recognition in quiet and noise by native and non-native listeners: Effects of age of immersion and vocabulary size. Astrid Z. Doty, Catherine L. Rogers (Dept. of Comm. Sci. and Dis. and Psych., Univ. of South Florida, 4202 E. Fowler Ave. PCD1017, Tampa, FL 33620), and Judith B. Bryant (Univ. of South Florida, Tampa, FL 33620)

In spoken word recognition, high-frequency words with few and less frequently occurring minimal-pair “neighbors” (lexically easy words) are recognized more accurately than low-frequency words with many and more frequently occurring neighbors (lexically hard words). [Bradlow and Pisoni, *J. Acoust. Soc. Am.*, 106, 2074–2085 (1999)] found a larger “easy-hard” word effect for non-native than native speakers of English. The present study extends this work by specifically comparing word recognition by non-native listeners with either earlier (age 10 or earlier) or later (age 14 or later) ages of immersion in an English-speaking environment to that of native English speakers. Listeners heard six lists of 24 words, each composed of 12 lexically easy and 12 lexically hard target words in an open-set word-identification task. Word lists were presented in quiet and in moderate background noise. A substantially larger easy-hard word effect was obtained only for the later learners, but a measure of oral vocabulary size was significantly correlated with performance for the non-native listener groups only. Thus, the increased easy-hard effect for non-native listeners appears to be better explained as an effect of phonetic proficiency and/or the effect of vocabulary size on the structure of lexical neighborhoods than as an effect of language competition.

5pSWa31. Perceptual adaptation to foreign accented speech. Melissa Baese-Berk (Dept. of Linguist., Northwestern Univ., 2016 Sheridan Rd., Evanston, IL 60208, m-baese@northwestern.edu)

Previous research on native listener adaptation to foreign-accented adaptation has demonstrated that training on a single non-native speaker results in talker-dependent learning (i.e., training does not generalize to new talkers). However, training on multiple foreign-accented speakers from a single language background results in talker-independent, but accent-dependent learning (i.e., training generalizes to new speakers of the trained accent, but not to new accents). The current study extends these findings, examining whether training on multiple accents can result in accent-independent learning. Native English listeners were trained on recognition of foreign-accented speech by five speakers from different language backgrounds. They were then tested on the speech of two novel speakers. One of the speakers was a native speaker of a language included in the training set (Mandarin), and the other was a native speaker of a language not included in the training set (Slovakian). Listeners demonstrated better performance on both the Mandarin and Slovakian tests than untrained control subjects, demonstrating accent-independent learning after training on multiple foreign accents. This suggests that individuals in multilingual communities, who are exposed to significant variation in the input, may be able to achieve highly flexible speech perception systems.

5pSWa32. Effects of audiovisual auditory and articulatory training on second-language (L2) vowel category learning. Cristina Aliaga-Garcia (Departamento de Filología Inglesa y Alemana, Universitat de Barcelona, Gran Via Corts Catalanes 585, 08007 Barcelona, Spain, cristinaaliaga@ub.edu)

Cross-language speech perception research has documented learners’ difficulties in using and accessing L2 durational and spectral information. This study investigated the short-term effects of two types of audiovisual high-variability phonetic training—auditory versus articulatory training—on the perception of the 11 English RP monophthongal vowels. Bilingual Catalan/Spanish learners of English ($N=20$ in each training condition) and one control group ($N=20$) were tested before and after training. Perceptual gains were assessed through a four-choice categorization task with natural CVC words, a forced-choice categorization task based on four synthesized /hVd/ continua (/i:/-/ɪ/, /æ:/-/ʌ/, /ʌ:/-/ɑ:/ and /u:/-/ʊ/), and an AX discrimination task including 16 contrasting pairs. Significant perceptual accuracy gains were obtained in both auditory and audiovisual conditions. Pre- and postcategorization of synthesized vowels suggests that vowel perception improved, and that both training modalities had a similar positive effect on the learners’ use of spectral and duration information in vowel categorization. These results are further discussed in terms of input effects on vowel category learning and the reweighting of acoustic cues through phonetic training.

5pSWa33. Semantic contextual cues and listener adaptation to foreign-accented English. Page Piccinini (2146 Sherman Ave., Apt. 1D, Evanston, IL 60201, p-piccinini@u.northwestern.edu) and Ann Bradlow (Northwestern Univ., 2016 Sheridan Rd., Evanston, IL 60208, abradlow@northwestern.edu)

The context surrounding words can facilitate word recognition for native and non-native listeners. However, for degraded speech signals, (e.g., with noise), non-natives may lose the ability to take advantage of contextual cues unless the speech is clearly produced [Bradlow and Alexander (2007)]. This study investigated whether: (1) foreign-accented speech degrades the signal such that natives show reduced ability to take advantage of context, and (2) both native and non-native listeners adapt to foreign-accented speech. Native and non-native listeners were exposed to accented speech in two blocks. In each block, half the sentence final words were in high and half were in low predictability contexts. Listeners were asked to identify sentence final words. In a single talker condition, natives benefited from context and adapted to the accent; non-natives could not use context but showed adaption. In a multitalker condition, natives neither benefited from context nor adapted to the accent. Non-natives benefited from context and adapted; however, the context effect was only seen when listener and speaker L1 matched. These results suggest that accented speech disrupts the native ability to take advantage of context, but this can be overcome by adaptation to the speaker. Non-natives benefit substantially from a talker-listener L1 match.

5pSWa34. Perception of dialectal variation: Can speakers of Western Canadian English perceive New Zealand English /r/-sandhi? Verona J. Dickout and Benjamin V. Tucker (Dept. of Linguist., Univ. of Alberta, 4-32 Assiniboia Hall, Edmonton, AB, Canada T6G 2E7)

The current study investigates perception of New Zealand English /r/-sandhi by speakers of Western Canadian English. It investigates whether speakers of Western Canadian English can differentiate between intrusive-/r/ (e.g., *sawing* [sæʊɹɪŋ]) and linking-/r/ (e.g., *soaring* [sæʊɹɪŋ]) of /r/-sandhi across morpheme boundaries and across word boundaries (e.g., linking: *boar and*, intrusive: *boa and*). Reaction time and accuracy were recorded in a two-alternative forced choice experiment. Stimuli showed significant acoustic differences between the linking-/r/ and intrusive-/r/ environments, with intrusive-/r/ having a shorter duration than linking-/r/. Participants were highly accurate and faster at recognizing words with linking-/r/ (e.g., *soaring*) and extremely inaccurate and slower at recognizing intrusive-/r/ (e.g., *sawing*). Participants’ responses to linking-/r/ at a morpheme boundary were significantly more accurate and faster than responses with linking-/r/ across word boundaries. The results of this experiment address the phonetic variability present in cross-dialect perception and begin to investigate strategies listeners utilize to accurately perceive speech.

5pSWa35. Perception of phonemic and allophonic contrasts in English- and Spanish-learning infants. Morgan Meredith (Commun. Sci. & Disord., Northwestern Univ., 2240 Campus Dr., Evanston, IL 60208, morgan.leigh@me.com) and Jessica Maye (Northwestern Univ., Evanston, IL 60208)

Infants from monolingual English- and Spanish-speaking homes were compared in their perception of two phonetic contrasts that differ in their phonemic status in the two languages. The contrast [d]-[ð] is phonemic in English but allophonic in Spanish; while the contrast [d]-flap is phonemic in Spanish but allophonic in English. Infants ranged from 6 to 16 months of age. Each infant was tested on discrimination of both contrasts. For half of the infants the stimuli were produced by a Spanish speaker, while for the other half of the infants the stimuli were produced by an English speaker. Data collection from Spanish-learning infants is still in progress. However, preliminary results indicate that infants in the youngest age group (6–8 months) are able to discriminate the [d]-flap contrast regardless of infant language background, while the [d]-[ð] contrast is discriminated poorly at this age in both language groups. English-learning infants lose sensitivity to the allophonic [d]-flap contrast with age, and it is not until 14–16 months that discrimination of the phonemic [d]-[ð] contrast improves in these infants. Spanish-learning infants are expected to remain proficient at discriminating the phonemic [d]-flap as they age and to remain poor at discriminating the allophonic [d]-[ð] contrast. [Work supported by NIH1R03HD048538 to JM.]

5pSWa36. The effects of linguistic experience on the perception of breathy phonation. Christina Esposito (Dept. of Linguist., Macalester College, 1600 Grand Ave., St. Paul, MN 55105, esposito@macalester.edu)

This study investigates the role linguistic experience has on the perception of phonation and the acoustic properties that correlate with this perception. Listeners from Gujarati (contrasts breathy versus modal vowels), Spanish (no breathiness), and English (allophonic breathiness) participated in two tasks. In the visual sort, subjects sorted breathy and modal vowels from a variety of languages into two groups based on perceived similarity of the talkers' voices. In the multidimensional scaling task, listeners heard pairs of Mazatec vowels, and moved a slider to indicate perceived similarity of vowels in each pair. Results showed that judgments were more uniform across subjects who had breathy categories present in their native language and varied across subjects who lack a breathy category. Despite allophonic breathiness, English listeners did no better at distinguishing phonations than Spanish listeners. The perceived similarity among the stimuli correlated with measurable acoustic properties (H1-H2, H1-A3, H1-A1, etc.). H1-H2 was the most salient acoustic property for Gujarati listeners (which correlates with their production of breathy vowels). English listeners relied weakly on the measure H1-H2, which is associated with the production of phonation in English. In addition, Spanish listeners, despite lacking a breathy category, relied on H1-H2 and H1-A1.

5pSWa37. Native language experience influences the perceived similarity of second language vowel categories. Thomas A. Farmer, Ran Liu, Neha S. Mehta, and Jason D. Zevin (Dept. of Psychiatry, Sackler Inst. for Develop. Psychobiol., Weill-Cornell Medical College, Box 140, New York, NY 10021, taf22@cornell.edu)

Most studies of L2 speech perception seek to characterize—at least implicitly—how the similarity among L2 speech sound categories is shaped by L1 experience. Intercategory similarity for native language speakers is rarely considered, however. Here, we derive two indices of graded intercategory similarity for a front vowel series (pin, pen, and pan): One from an off-line perceptual similarity judgment task and a second from online measures of arm-movement trajectories in a word recognition task. Both tasks revealed graded effects of intercategory similarity, but the similarity spaces differed between language groups. Both groups perceived /ae/ and /E/ to be most similar, but the native Italian speakers perceived /I/ to be equally similar to /E/ and /ae/, whereas English speakers perceived the /I/ and /E/ to be more similar than /I/ and /ae/. The Italian speakers' performance in both tasks suggests a similarity space that is dominated by dimensions that are

contrastive for /I/ with respect to the other vowels. This may reflect a compensatory strategy for L2 vowel perception that may derive from experience with the distributional properties of their native vowels.

5pSWa38. The role of linguistic experience in the hemispheric perception of Mandarin tone. Shuang Lu (Prog. in Linguist., Univ. of Florida, Gainesville, FL 32611-5454, shuanglu@ufl.edu), Vincent J. van Heuven (Leiden Univ., 2300 RA Leiden, the Netherlands), and Ratree Wayland (Univ. of Florida, Gainesville, FL 32611-5454)

The current study investigated whether and to what extent lexical tone is processed as linguistic information by native Mandarin listeners, early Mandarin-Dutch bilinguals, second year Dutch students of Chinese, and monolingual Dutch students. Dichotic listening task was conducted in each of the four groups in order to determine to what extent the processing of lexical tones in Mandarin was lateralized to the left hemisphere. The majority of native Mandarin listeners revealed a right-ear advantage (REA) corresponding to a left-hemisphere lateralization in the perception of Mandarin tones. Similar to the native Chinese listeners, the Dutch-Mandarin bilinguals also exhibited an REA. Moreover, the left-hemisphere dominance was even more evident for these proficient bilinguals than for the native listeners. However, the Dutch listeners without any experience with Mandarin or other tonal languages showed no ear advantage. For the second year Chinese major listeners, five listeners revealed an REA, while others exhibited a bilateral pattern. The results suggested that there is a tendency for a right-ear advantage corresponding to left-hemisphere superiority for listeners with at least some basic experience of Mandarin tones.

5pSWa39. Category formation and lexical encoding of a new contrast. Isabelle Darcy, Laurent Dekydtspotter, Rex A. Sprouse (Dept. of Second Lang. Studies, Indiana Univ., 1021 E Third St., Bloomington, IN 47405, idarcy@indiana.edu), Christiane Kaden, John H. G. Scott, Vance Schaefer, and Michael McGuire (Indiana Univ., Bloomington, IN 47405)

The question whether category formation is a prerequisite for U.S.-English learners of French to encode a non-native contrast in lexical representations is investigated, looking at front [y-œ] and back [u-ɔ] rounded vowels. An ABX categorization experiment revealed no group difference between advanced ($N=18$) and inexperienced learners ($N=18$). Both made significantly more errors than French controls ($p<0.01$) on the [u-y] contrast, despite a good global discrimination (15% error). The possibility that minimal pairs of difficult contrasts (e.g., *sourd* [sur] deaf vs *sur* [syʁ] sure) are stored as homophones was tested in a lexical decision task with repetition priming. French words and non-words were paired with either themselves (*repetition*) or a minimal-pair-counterpart (*minimal pair*) in a 260 item list. Correct RTs were measured for each item. Given a comparable RT-advantage on the *repetition* and the *minimal pair* condition, merged lexical representations were assumed. Advanced learners, like native speakers, showed no RT-advantage for *minimal pair* conditions; inexperienced learners displayed significant facilitation for [u-y] and [ɔ-œ] minimal pairs (but not [i-y] control condition). This suggests that successful lexical contrast is possible for advanced English-French users despite persistent perception errors—the hallmark of an insecure category establishment—presenting an argument for the dissociation of both mechanisms.

5pSWa40. Relationship of prosody by Spanish speakers of English as a second language on the perception of intelligibility and accentedness by native English listeners. Paul Edmunds (Dept. of Linguist., Univ. of New Mexico, MSC06 3850, 1 University of New Mexico, Albuquerque, NM 87131)

The degree to which prosodic features related to English lexical stress affect the perception of factors such as intelligibility and accentedness by native English listeners was investigated. Acoustic analyses of English multi-syllabic words spoken by native Spanish speakers who learned English as a second language (ESL) were used to determine the values of the acoustic correlates of lexical stress of these speakers on a set of target words. Values for vowel duration, intensity, and fundamental frequency produced by the Spanish ESL speakers were compared to those values produced by native English speakers. Prosodic variation observed in the ESL speakers was used to formulate a range for manipulations to the target words. To focus solely on prosody and not take into account consonant and vowel quality, manipulations, using the PSOLA algorithm in Praat, were done to the

voices of native English speakers. These manipulations captured increases and decreases in duration, intensity, and fundamental frequency on vowels that should or should not carry lexical stress in a particular target word. Listeners rated the resynthesized tokens for factors such as intelligibility and accentedness, and the results suggest that a speaker's prosody alone can influence a native listener's judgments on these variables.

5pSWa41. The benefit of variation in cross-language perception of voice onset time (VOT). Meghan Sumner (Dept. of Linguist., Margaret Jacks Hall, Bldg. 460, Stanford Univ., Stanford, CA 94305-2150)

Listeners are consistently able to adjust to perceptually ambiguous sounds (Norris *et al.*, 2003; among others). When listeners are exposed to sounds ambiguous between two phonetic categories, boundaries adjust to the ambiguous signal. Perceptual learning has been suggested to account for adjustment to unfamiliar accents. It is not necessarily true, though, that this flexibility extends to more extreme cases of variation. Many sounds in accented speech are unambiguously mapped to the wrong category (e.g., unaspirated voiceless stops in French-accented English are perceived as voiced by native English listeners). We examined English listeners' perception of accented English in a perceptual learning paradigm with two exposure conditions: native French VOT mean and range in words that are lexically unambiguous (e.g., poach, *boach, not pet bet). Perceptual learning completely fails when listeners are exposed to the mean VOT, and in fact, this is coupled with an expanded voiced category, even though the words are lexically biased. Listeners make large adjustments when exposed to a range of VOTS, even those that are not good exemplars of English voiceless stops.

The results are counter to models that suggest less variability improves learning, and suggest that variability in speech is used by and beneficial for listeners.

5pSWa42. The impact of native inventory versus native contrast on vowel discrimination. Marc Ettlinger (The Roxelyn and Richard Pepper Dept. of Commun. Sci. and Disord., Northwestern Univ., 2240 Campus Dr., Evanston, IL 60208, marc@northwestern.edu) and Keith Johnson (Univ. of California, Berkeley, Berkeley, CA 94720)

Theories of speech perception differ as to whether experience with sounds or with sound contrasts is more important when discriminating novel sounds. To explore this question, 21 American English, 16 Turkish, and 16 French speakers were tested on their ability to discriminate high front vowels in German (/i/~/y/~/Y/~/I/). The crucial difference between the participant languages is that English only uses the tense-lax contrast (/i/~/I/), while Turkish and French only use the rounding contrast (/i/~/y/). If contrast is crucial, then English speakers should be better at discriminating /y/~/Y/, whereas if the inventory is crucial, then they should be better at discriminating /I/~/Y/. The results of a fixed discrimination task show that there is no significant effect of language and that the tense-lax contrast (/i/~/I/; /y/~/Y/) is universally more easily discriminated than the rounding contrast (/i/~/y/; /I/~/Y/). The results of a rating task do reflect an influence of language, however with English-listeners rating /I/~/Y/ as more distinct and French and Turkish speakers rating /y/~/Y/ as more distinct. So, because English has /I/, but no rounding contrast, what matters in the perception of new sounds is not experience with contrasts, but rather experience with particular sounds.

FRIDAY AFTERNOON, 22 MAY 2009

SKY BRIDGE AUDITORIUM, 3:15 TO 4:45 P.M.

Session 5pSWb

Speech Workshop: Training and Adaptation of Speech Perception in Laboratory Contexts

Paul Iverson, Chair

Phonetics and Linguistics, University College London, London NW1 2HE, U.K

Contributed Papers

3:15

5pSWb1. Experience with computerized speech-perception training (SPATS-ESL) for speakers of other languages learning English. James D. Miller, Roy Sillings, Charles S. Watson (Commun. Disord. Technol., Inc., 501 N. Morton Str., Sta. 215, Bloomington, IN 47404), Isabelle Darcy, and Kathleen Bardovi-Harlig (Indiana Univ., Bloomington, IN 47405)

SPATS-ESL evolved as it was used by volunteers and as a supplement to classes in the Intensive English and English Enhancement Programs at Indiana University (Bloomington). These trials with eighty ESL-learners representing 12 L1s resulted in the curriculum described in the companion poster. Before training, the ESL learners exhibited significant problems with perceiving spoken English. These were greatest for syllable nuclei, least for syllable onsets, and intermediate for syllable codas. Recognition of spoken sentences was also inferior to that of native speakers of English. Improvement on all tasks including sentence recognition was proportional to the total time spent with SPATS. Based on the data and on reasonable extrapolations therefrom, many ESL-learners, after 20–30 hours of spaced practice with SPATS-ESL, appear to be approaching the performance of native-speakers of English on all SPATS-ESL tasks. Responses to questionnaires and comments indicate that the participants believed that SPATS-ESL training (a) was useful, (b) should be used in other classes, (c) helped them understand native speakers in real-life situations, and (d) would help them to improve their pronunciation of English. More advanced students were more

enthusiastic about SPATS-ESL than less advanced students. Individual and group data supporting these generalizations and extrapolations will be presented.

3:33

5pSWb2. The role of selective attention in the acquisition of English tense and lax vowels by native Spanish listeners: Comparison of three training methods. Maria V. Kondaurava (Dept. of Otolaryngol., Head and Neck Surgery, Indiana Univ. Sch. of Medicine, 699 West Dr., RR044, Indianapolis, IN 46202, mkondaur@iupui.edu) and Alexander L. Francis (Purdue Univ., West Lafayette, IN 47906)

This study investigates the role of two processes, cue enhancement (learning to attend to acoustic cues which characterize a speech contrast for native listeners) and cue inhibition (learning to ignore cues that do not), in the acquisition of the American English tense and lax ([i] and [ɪ]) vowels by native Spanish listeners. This contrast is acoustically distinguished by both vowel spectrum and duration. However, while native English listeners rely primarily on spectrum, inexperienced Spanish listeners tend to rely exclusively on duration. Twenty-nine native Spanish listeners, initially reliant on vowel duration, received either enhancement training, inhibition training, or training with a natural cue distribution. Identification results demonstrated that, although listeners in all training groups increased their reliance on spectrum while decreasing reliance on duration, inhibitory and enhancement methods were significantly better than natural distribution training. Adaptive training was also more successful than the other methods for increasing be-

tween category distinctiveness on a discrimination task. These results suggest that phonetic learning may involve two distinct cognitive processes, cue enhancement and cue inhibition, that function to shift selective attention between separable acoustic dimensions. Moreover, cue-specific training (whether enhancing or inhibitory) appears to be more effective for the acquisition of second language speech contrasts.

3:51

5pSWb3. Investigating non-native category learning using a video-game-based training paradigm. Sung-joo Lim and Lori L. Holt (Dept. of Psychol., Carnegie Mellon Univ., 5000 Forbes Ave., Pittsburgh, PA 15213, sungjol@andrew.cmu.edu)

Adults have difficulty learning non-native speech categories, presenting an opportunity to study adult learning and plasticity with non-native speech categorization. Long-term training within laboratory-based response-feedback paradigms has produced modest non-native category learning in previous studies. The current study investigates the effectiveness of a video-game-based categorization training paradigm, found to be effective in learning novel nonspeech auditory categories [W. Holt, (2005)], to train native Japanese adults to categorize English /r/ and /l/. This approach emphasizes functional associations between sound categories and players' responses to video-game characters rather than overt phonetic categorization. Although categorization is not explicit in the game it is helpful to overall performance, providing a functional and perhaps more ecologically valid training signal than traditional feedback in standard laboratory training procedures. Japanese participants who played the game for about 2.5 h across 5 days with /r/ and /l/ sounds matched to game characters showed more nativelike perception of English /r/ and /l/ than control participants who played the game with nonspeech sounds. Listeners' categorization performance furthermore reflected regularities of the /r/-/l/ input distributions. In particular, variability across second-formant (F2) frequency may have encouraged listeners to shift perceptual cue weights toward more nativelike use of third formant (F3) frequency.

4:09

5pSWb4. Perception-production loop in native-non-native dialogs: Phonetic convergence. Natalie Lewandowski and Grzegorz Dogil (Inst. for Natural Lang. Processing, Univ. of Stuttgart, Azenbergstr. 12, 70174 Stuttgart, Germany, natalie.lewandowski@ims.uni-stuttgart.de)

The present study investigated the relation between the ability to adapt to the speech of a foreign language dialog partner and the individual variable of language talent. It was assumed that the actual degree to which one can converge to another speaker's pronunciation actually depends on his/her ability to pay attention to fine phonetic detail, to encode it, and to immediately reuse it in running speech—which was defined as phonetic talent. In order to analyze convergence in dialog, ten speakers of German (classified into two groups according to their proficiency and talent) performed a Diapix-task with a British and an American English conversational partner. Our main research goal can be described as follows: Does phonetic talent play a role in the perception-production loop and influence the process of accommodation towards a foreign dialog partner? The statistical analysis of the acoustic measurements revealed a significant effect for the factor talent across the American/British English conditions and also within the AE condition, indicating that the talented speakers have converged more. All results will be discussed assuming an underlying dynamic process, possibly involving a simultaneous interplay of convergence as well as divergence within a conversation.

4:27

5pSWb5. Second language influence on perception of first language phonotactics. Cynthia Kilpatrick (UCSD Linguist., 9500 Gilman Dr., #0108, La Jolla, CA 92093-0108)

The results of a speech perception experiment are reported, examining the responses of speakers of the same L1 (Spanish) with varying experience in the L2 (English). Three groups of speakers participated in a wordlikeness rating task in Spanish, in which nonce words were presented in sets that varied as to whether the final consonant of the word was phonotactically legal or illegal: (1) bilinguals who learned both English and Spanish before the age of 5, (2) L1 Spanish speakers that learned English after the age of 12, (3) monolingual speakers without communicative exposure to a second language. All groups differed significantly in the strength of their overall ratings, even though all speakers were technically native speakers of Spanish. In addition, for both the bilingual and second language speakers, ratings for legal vs illegal codas were significantly different. For monolingual speakers, on the other hand, ratings for legal and illegal codas were similar, but response times for these two conditions were significantly different. These results support the idea that native speaker judgements are affected by the extent of language experience that a speaker possesses, and the processing of phonotactic legality may not proceed similarly for monolingual, second language, and bilingual speakers.

Session 5pSWc**Speech Workshop: Keynote Address**

Catherine T. Best, Chair

*MARCS Auditory Labs., Univ. of Western Sydney, Penrith South DC, NSW 1797, Australia***Chair's Introduction—5:00*****Invited Paper*****5:05**

5pSWc1. Automatic selective perception (ASP) of first-language (L1) and second-language (L2) speech: A working model.
Winifred Strange (Speech Acoust. and Percept. Lab., CUNY-Graduate School, 365 Fifth Ave., New York, NY 10016-4309, strangein@aol.com)

In this model, speech perception by adults is characterized as an active, information-seeking process whereby native listeners detect the most reliable acoustic parameters that specify phonetic segments and sequences, using highly over-learned, automatic selective perception routines. In laboratory perceptual tasks, differentiation of native (L1) phonetic contrasts is rapid and robust in suboptimal listening conditions even when the listeners focus on other levels of language structure, or indeed on another task. In contrast, late L2 learners must employ greater attentional resources in order to extract sufficient information to differentiate phonetic contrasts that do not occur in their native language. Phonetic and phonological modes of speech perception are described, which can be tapped in the laboratory by manipulations of stimulus complexity and task demands. These experimental manipulations reveal complex interactions between the linguistic experience of listeners and phonetic similarity relationships between L1 and L2 phonological inventories. Illustrative experimental evidence from studies of vowel perception using perceptual assimilation (cross-language identification), speeded discrimination, discrimination in speech babble, and brain indices of discrimination (MMN) will be presented to provide operational definitions of these concepts. Similarities and differences from other current theories of cross-language and L2 speech perception will be discussed. [Work supported by NIH, NSF.]

5:50—6:15 panel-discussion**Session 6aSWa****Speech Workshop: New Perspectives on Developmental Models**

Ann R. Bradlow, Chair

*Dept. of Linguistics, Northwestern Univ., Evanston, IL 60208***Chair's Introduction—9:00*****Invited Papers*****9:05**

6aSWa1. Infant magnetoencephalography studies exploring neural links between sensory and motor representations for speech.
Patricia K. Kuhl (Univ. of Washington, Inst. for Learning & Brain Sci., Mailstop 357920, Seattle, WA 98195-7920, pkkuhl@u.washington.edu)

The adult brain exhibits anatomical and functional specialization specific to speech, but we have little information regarding the infant brain. Recent adult neuroimaging studies show that speech processing is left-lateralized and that two regions of the brain, the superior temporal (ST, auditory area) and inferior parietal (IF, motor area), contribute to the brain's response to speech. To explore brain activation to speech and nonspeech in infants, we used magnetoencephalography to image the whole brain. Experiment 1 examined infants at three ages: newborn, 6 months, and 12 months. Infants showed significant ST activation to both speech and nonspeech stimuli. IF activation was not observed in newborns but in the two older groups of infants we observed synchronous IF and ST activation that was unique to speech. Experiment 2 investigated the nature of this perceptual-motor coupling for speech—specifically, we asked whether synchronous activation reflects the detection of speech signals per se, or whether it signals the recognition of experienced (native-language) speech. Native, non-native, and nonspeech analogs were used to test these alternatives. Our results elucidate the developmental time course of the sensory-motor connections for speech, and address longstanding theoretical issues in speech perception.

6aSWa2. Bilingual beginnings as a lens for theory development. Janet F. Werker, Suzanne Curtin, and Krista Byers-Heinlein (Dept. of Psych., Univ. of British Columbia, 1236 West Mall, Vancouver, BC V6T 1Z4, Canada, kbyers@psych.ubc.ca)

Phonetic categories become language specific across the first months of life. However, at the onset of word learning there are tasks in which infants fail to utilize native language phonetic categories to drive word learning. In 2005, we advanced a framework to account for why infants can detect and use phonetic detail in some tasks but not in others (Werker and Curtin, 2005; see also Curtin and Werker, 2007). In this framework, PRIMIR (processing rich information from multidimensional, interactive representation), we argue that by their first birthday, infants have established language-specific phonetic category representations, but also encode and represent both subphonetic and indexical details of speech. Initial biases, developmental level, and task demands influence the level of detail infants use in any particular experimental situation. On some occasions phonetic categories are accessed, but in other tasks they are not given priority. Recently, we have begun studying infants who are exposed to two native languages from birth (Werker and Byers-Heinlein, 2008). In the current paper, we will review recent work on speech perception and word learning in bilingual-learning infants. This will be followed by a discussion of how this research has led to advances in, and changes to, PRIMIR.

SATURDAY MORNING, 23 MAY 2009

SKY BRIDGE AUDITORIUM, 10:30 A.M. TO 12:15 P.M.

Session 6aSWb

Speech Workshop: Early Bilingual Development

Susan G. Guion, Chair

Dept. of Linguistics, Univ. of Oregon, Eugene, OR 97403-1290

Invited Papers

10:30

6aSWb1. Phonetic variability in bilinguals' acquisition of native-vowel category contrasts. Laura Bosch and Marta Ramon-Casas (Dept. of Basic Psych., Univ. of Barcelona, 171 P. Vall d'Hebron, Barcelona 08035, Spain)

Previous research has shown that bilingual infants and toddlers follow a slightly different developmental pattern in building and stabilizing some native vowel contrastive categories, compared to monolingual populations. Once in the lexical stage, bilingual toddlers do not always show the expected mispronunciation effect when presented with familiar words in which a vowel change has been introduced. To better understand bilinguals' protracted process in setting the boundaries for certain, perceptually close, native vowel categories, a phonetic analysis of the input characteristics was undertaken. Speech samples containing target words with Catalan mid-front vowel sounds were recorded from two groups of Catalan-speaking mothers from monolingual and bilingual environments, differing in the use of their L2 (Spanish). First and second formant values of the target vowels were obtained and compared between groups. The vowels were always correctly and contrastively produced, but bilinguals' formant values differed significantly from monolinguals': categories were closer in space and greater variability in production was found. Young bilinguals' sensitivity to phonetic variability in the words they hear may constrain the development of neat representations of contrastive vowel categories in the early lexicon. [Work supported by CONSOLIDER 2010 Program (CSD2007-012).]

11:05

6aSWb2. How are speech sound categories acquired in bilingual first language acquisition? Megha Sundara and Adrienne Scutellaro (Dept. of Linguist., UCLA, 3125 Campbell Hall, Los Angeles, CA 90095-1543, megha.sundara@humnet.ucla.edu)

For bilingual infants, phonetic categories of the two languages develop interdependently. This is supported by the differences in time course and trajectory of development of phonetic perception between Spanish-Catalan bilingual and monolingual infants (Bosch and Sebastián-Gallés, 2003a, 2003b, 2005; Sebastián-Gallés and Bosch, in press). Bosch and Sebastián-Gallés argue that for similar phones, at least initially, infants track statistical regularities across the two languages. This results in a temporary inability of bilingual infants to discriminate acoustically similar phonemes. Research on French-English bilingual infants shows a different pattern. There is evidence that French-English bilingual infants may not differ from their monolingual peers in discrimination of phonetic contrasts (Burns *et al.*, 2007; Sundara *et al.*, 2008). In this talk, data will be presented from Spanish-English bilingual infants to evaluate how development of phonetic perception is affected by (a) frequency of phones and (b) the rhythmic (dis)similarity of the two languages to which bilinguals are exposed.

11:40

6aSWb3. The development of English vowel perception in monolingual and bilingual infants: Neurophysiological correlates. Valerie L. Shafer (Program in Speech-Lang.-Hearing Sci., The Graduate Ctr., CUNY, 365 Fifth Ave. NY, NY 10016)

This research examines the maturation of I-E vowel discrimination, in terms of neurophysiological responses, in infants exposed monolingually to English or bilingually to English and Spanish. The vowels [I] as in "pit" and [E] as in "pet" contrast meaning in English but not in Spanish. Bilingual exposure to English and Spanish alters the distribution of phonetic information heard by an infant and may alter the timecourse of vowel category development in the two languages [e.g., L. Bosch and N. Sebastian-Galles (2003)]. The goal of the current study is to examine whether there is evidence from brain responses indicating differences in the development of this English vowel category as a function of amount of English versus Spanish in the input. Preliminary results reveal that both monolin-

gually and bilingually exposed infants and children show evidence of good discrimination of the English vowels, but that the groups with bilingual exposure more often show increased contribution of the right hemisphere to discrimination compared to the groups receiving monolingual exposure. It is not currently clear why these hemispheric differences are found, but they may be related to differences in how attention is allocated in processing the vowels. [This research was supported by NIH HD46193.]

SATURDAY AFTERNOON, 23 MAY 2009

SKY BRIDGE TERRACE, 1:30 TO 3:00 P.M.

Session 6pSWa

Speech Workshop: Cross-Language Speech Perception and Linguistic Experience: Poster Session C

Suzanne L. Curtin, Chair

Dept. of Psychology, Univ. of Calgary, Calgary, AB T2N 1N4, Canada

Contributed Papers

All posters will be on display from 1:30 p.m. to 3:00 p.m. To allow contributors an opportunity to see other posters, contributors of odd-numbered papers will be at their posters from 1:30 p.m. to 2:15 p.m. and contributors of even-numbered papers will be at their posters from 2:15 p.m. to 3:00 p.m.

6pSWa1. English vowel perception by native speakers of European Portuguese and Mandarin. Andreia S. Rauber (Ctr. for Humanistic Studies, Univ. of Minho, Campus de Gualtar, Braga, Portugal 4715-057, arauber@ilch.uminho.pt)

This study investigated the perception of eight American English stressed syllabic monophthongs (/i, I, E, æ, V, O, U, u/) by two groups of nonnative listeners: Portuguese and Chinese. Each group was formed by 15 English as a foreign language (EFL) learners, with an upper-intermediate level of English proficiency, all undergraduate students at a Portuguese university. An identification test was designed to investigate how the participants would perceive the English vowels, which are not present in their first language (L1) inventory as stressed monophthongs (/I, æ, V, U/ in the case of the Portuguese speakers, and all vowels but /i, u/ in the case of the Mandarin speakers). The large number of target vowels played as stimuli allowed a cross-language analysis of vowel distribution in the acoustic space: for the two groups of EFL listeners, it was more difficult to perceive the English vowels located in a high density area of the English vowel space than those in less crowded areas. For the two groups of speakers, the vowels /æ/ and /U/ had the greatest misidentification rates.

6pSWa2. Does the native language use of duration affect the perception of non-native length contrasts? Yukari Hirata (Dept. of East Asian Lang. and Lit., Colgate Univ., 13 Oak Dr., Hamilton, NY 13346, yhirata@colgate.edu) and Motoko Ueyama (Univ. di Bologna, 47100 Forlì, Italy)

This study compared native Italian (NI) and American English (NE) speakers' abilities to perceive Japanese phonemic length contrasts. Japanese has both vowel and consonant length contrasts, Italian has only consonant length contrast, and English has neither. The study examined to which extent the differential use of duration in their native languages affects their abilities to perceive length contrasts in an unfamiliar language. Twenty-two monolingual NI speakers perceived Japanese words in isolation and in sentences and were asked to identify the number of moras in target words, e.g., /o.do.t.ta/ as four moras. Their test scores were compared to those of 18 NE participants [Hirata (2004)] in an analysis of variance. Group (NE, NI) was a between-subjects factor, and context (isolation, sentences) and word type (long vowels, geminates, combination, and short segments) were within-subjects factors. While there was no main effect of group (NI: 44.6%; NE: 39.5%), there was a significant three-way interaction. The NI group scored significantly higher than the NE group on words with geminates spoken in sentences (43.3 vs 31.1%). Results are discussed as to whether the perception of non-native length contrasts is driven by language-specific ability [McAllister *et al.* (2002)] or by more general auditory ability [Bohn (1995)].

6pSWa3. Linguistic experience in tone perception. James Kirby (Phonology Lab., Dept. of Linguist., 1010 E 59th St., Chicago, IL 60637, jkirby@uchicago.edu)

This paper examines the effect of regional dialect on tone perception. Thirty speakers of Northern and Southern Vietnamese performed an AX discrimination task using natural speech tokens of Northern (NVN) speech. NVN distinguishes six tones, three of which are produced with creaky voice, while Southern Vietnamese (SVN) distinguishes only five tones, none of which are canonically produced with creaky voice; however, both groups of listeners have shown some sensitivity to voice quality as well as F0 cues (Brunelle, 2008). While the results of hierarchical cluster analysis show both Northern and Southern listeners broadly group tones by F0 onset, multidimensional scaling shows the effects of dialect-specific perception: despite some familiarity with NVN speech, SVN listeners did not adjust their perceptual cue space when listening to NVN talkers. As a result, tones with similar F0 profiles but different voice qualities were more likely to be confused by SVN listeners. This is consistent with studies showing that perceptual processes are organized in a language-specific fashion, with the acoustic cue space weighted by phonological relevance to L1 perception (Werker and Tees, 1999; Strange, 2002). It is argued that language-specific prosodic as well as segmental experience affects speech processing at the prelexical level.

6pSWa4. Cross-linguistic interpretation of duration. Ellen Broselow, Jiwon Hwang (Dept. of Linguist., Stony Brook Univ., Stony Brook, NY 11794-4376, ellen.broselow@stonybrook.edu), and Nancy Squires (Stony Brook Univ., Stony Brook, NY 11794)

In Korean, intervocalic [l] is realized as tap ([tal]/[tar-i] 'moon/moon+nom'). In English loanwords, however, intervocalic /l/ is generally adapted as a geminate lateral ([sollo] 'solo' but [sara] 'Sarah'). We present evidence from event-related potentials supporting an analysis in which Korean listeners perceive intervocalic single [l] (illegal in Korean) as geminate [ll], reinterpreting the English [r-l] contrast in terms of the Korean [r-ll] contrast ([dari] 'bridge', [dalli] 'differently'). Korean and English participants heard two sets of oddball paradigms, [ele-elle] and [ene-enne]. In both cases, the acoustic difference is the same, 48 versus 98 msec. However, the nasal pair represents a cross-category contrast in Korean ([kanan] 'poverty', [kannan] 'newborn') while the lateral pair represents a noncontrastive difference. Consistent with studies showing a stronger mismatch negativity (MMN) to cross-category changes than to within-category changes, Korean listeners displayed a significantly larger MMN for the nasal pair than for the lateral pair. In contrast, English listeners (for whom the pairs do not differ in categorical status) did not show significantly different responses to the durational changes in nasals versus laterals. Korean listeners' relatively weak

response to durational differences in laterals suggests that their adaptation pattern reflects inaccurate mapping of the acoustic signal to phonological representations. [Work supported by NSF BCS-07460227.]

6pSWa5. Informational masking in first- and second-language speech recognition. Kristin J. Van Engen (Dept. of Linguist., Northwestern Univ., 2016 Sheridan Rd., Evanston, IL 60208, k-van@northwestern.edu)

Human speech recognition in noisy conditions is modulated by cognitive factors such as language background. For example, noise is more detrimental to non-native listeners than native listeners (e.g., van Wijngaarden *et al.*, 2002), and when noise is a speech signal, native-language noise is more detrimental than foreign-language noise for listeners attending to native-language speech targets (e.g., Van Engen and Bradlow, 2007). It is not clear, however, whether this increased interference is primarily due to the native status of the noise or to the greater similarity between target and noise. To address this issue, English speech recognition in the presence of English and Mandarin babble was assessed for monolingual English listeners and L2 English listeners whose L1 is Mandarin. Results showed that intelligibility for both groups was lower in English versus Mandarin babble; that is, L2 listeners experienced more difficulty in same-language noise versus native-language noise. However, monolingual English listeners showed a greater release from masking in Mandarin noise than did L1 Mandarin listeners. The informational masking imposed on speech targets by interfering speech noise, therefore, is dependent both on the linguistic and/or acoustic similarity between the noise and the target and on the listeners' experience with the languages involved.

6pSWa6. Discrimination of English, French, and Spanish liquids by Japanese listeners. Tomohiko Ooigawa (Graduate School of Foreign Studies, Phonet. Lab., Sophia Univ., 7-1 Kioi-cho, Chiyoda-ku, Tokyo, Japan, ooiawaferchichi@gmail.com)

The present study examines the discrimination of English, French, and Spanish intervocalic liquids' contrasts (English /l/-r/, French /l/-r/, and Spanish /l/-r/, /l/-rr/, /l/-rr/) by native speakers of Japanese. The results show that the Japanese listeners discriminated the contrasts of French liquids and Spanish trill versus lateral/tap at the rate of more than 95%. On the other hand, they poorly discriminated the contrasts of English liquids and Spanish tap versus lateral. This study discusses whether the current models on second language speech perception account for the phenomena. It has been said that native speakers of Japanese have difficulty in distinguishing the contrasts of liquids both productively and perceptually. A lot of empirical studies on the perception of English liquids by Japanese listeners have been carried out so far. However, there are few empirical studies on the perception of other languages' liquids by Japanese listeners. This is the first study which compares the discrimination of the liquids of the three languages by native speakers of Japanese. In the experiment, utterances of /peCV/ were recorded from the native speakers of the three languages. AXB task was used for the perception experiment.

6pSWa7. Discrimination of four English vowel contrasts by Catalan learners varying in language experience. Lucrecia Rallo Fabra (Univ. of the Balearic Islands, ctra. Valldemossa, km. 7.5, 07122 Palma de Mallorca, Spain)

PAM-L2 (Best and Tyler, 2007) hypothesizes that discrimination of L2 sounds can be predicted from the perceptual relatedness of L2 categories to L1 categories. Catalan EFL learners encounter serious difficulties to discriminate some English vowel contrasts, partly because Catalan has a smaller vowel inventory than American English. This study presents data from a perceptual discrimination test in which three groups of EFL learners varying in experience with English were asked to discriminate a series of potentially difficult English vowel pairs. The discrimination task consisted in picking the odd item out of three stimuli which were heard one after the other at 1.3-s intervals. The target vowel stimuli occurred in CVC syllables produced by six native English talkers. Four vowel contrasts were tested: /lopena/-linv/, /leh-/laelig/, /i-/smallIII/, and /u-/smallUI/. As predicted by PAM-L2, "category-goodness" contrasts /i-/smallIII/ and /u-/smallUI/ were fairly well discriminated, the "single-category" contrast /lopena/-linv/ was poorly discriminated. The "uncategorized" contrast /leh-/laelig/ failed to meet PAM-L2 predictions, learners failed to distinguish these two vowels although the contrast was predicted as relatively easy to discriminate. Lan-

guage experience did not have a significant effect on ease of discrimination. These results suggest that PAM-L2 assimilation patterns can also be extended to EFL learning.

6pSWa8. Language preference in monolingual and bilingual infants. Linda Polka, Ayasha Valji (School of Commun. Sci. and Disord., 1266 Pine Ave. W., McGill Univ., Montreal, QC H3G 1A8, Canada, linda.polka@mcgill.ca), and Karen Mattock (Lancaster Univ., Fylde College, Bailrigg, Lancaster LA1 4YW, UK)

Previous research shows that infants in single-language families have some basic language discrimination abilities at birth which improve rapidly over the first 6 months of life, and that attention to the rhythmic properties of language supports these skills. Babies in monolingual families also prefer listening to their native language over an unfamiliar language when presented samples produced by one bilingual or two monolingual talkers. In this study we investigate the emergence of language-specific speech processing in bilingual infants by comparing language preference patterns in monolingual English, monolingual French, and bilingual English-French infants using a three-way language preference test. Listening times were measured to passages of adult-directed speech from three rhythmically different languages (English, French, Japanese; three talkers per language). Ten-month-olds in the monolingual groups listened equally to all three languages. However, 10-month-old bilinguals showed a significant preference for each native language over Japanese; listening times to English and French were not different. Individual bilingual 10-month-olds preferred the more prevalent native language in their input. These findings indicate bilingual infants listen more selectively when they encounter different languages. The implications of these findings for understanding speech processing in early bilingual acquisition will be discussed. [Work supported by SSHRC.]

6pSWa9. The perception of Georgian ejective stops by native English speakers. Christopher S. Doty and Susan G. Guion (Dept. of Linguist., 1290 Univ. of Oregon, Eugene, OR 97403-1290, cdoty@uoregon.edu)

The present study examined the perception of Georgian voiced, voiceless aspirated, and ejective stops by native speakers of English. It was motivated by the observation that languages with three stop-manner series often borrow voiceless aspirated stops as ejectives in a systematic manner. This is likely due to the perceptual similarity between aspirated stops in source language and the ejective stops in the borrowing language. To test the hypothesized perceptual similarity between aspirated and ejective stops, five English speakers were asked to listen to stops which varied in manner of articulation (voiced, voiceless aspirated, ejective) that were produced by a speaker of Georgian. Participants heard three productions at the same place of articulation, one of which differed in manner, and were asked to identify the oddball stop. The results indicated that the contrast between voiceless aspirated and ejective stops was correctly identified less often than the other two contrasts (voiced versus aspirated, voiced versus ejective) [$p < 0.05$]. No significant difference was found for the other contrasts. These data are supported by the results from a second task, in which the same participants performed a forced-choice identification and goodness rating task with the same productions.

6pSWa10. Perception-production relationship in French vowel learning in adulthood. Erika S. Levy (Speech-Lang. Pathol., Biobehavioral Sci., Teachers College, Columbia Univ., 525 W. 120th St., Box 180, New York, NY 10027, elevy@tc.columbia.edu) and Franco Law, II (City Univ. of New York-Grad. Ctr., New York, NY 10016-4309)

The present study examined the extent to which perceptual performance by American English (AE) individuals predicted their accuracy in producing second-language (L2) Parisian French (PF) vowels. Three groups of AE participants (no, moderate, and extensive French-language experience) participated in two perceptual tasks (categorical discrimination and perceptual assimilation), and a production (repetition) task involving PF /y-æ-i-a-u/ in bilabial /rabVpa/ and alveolar /radVta/ contexts within a phrase. Results from perception tasks correctly predicted overall production difficulties and effects of language experience and consonantal context in L2 production. Paralleling their perceptual patterns, front rounded vowel productions by AE participants were mislabeled more often as back rounded vowels than as front vowels by native-French speakers. PF /æ/ was produced more accurately with greater L2 experience. Production accuracy of /y/ was also

greater with extensive experience, a finding not expected based on minimal language-experience effects on /y/ perception. Productions of PF /u/ were identified approximately twice as accurately in bilabial context as in alveolar, in a pattern consistent with discrimination performance. Thus, PF /u/ may be considered a "similar" vowel in alveolar context, but not in bilabial, suggesting an allophonic level of representation in L2 learning, both in perception and production.

6pSWa11. Time-course of perception of Mandarin Chinese tones. Chiung-Yun Chang and Robert Allen Fox (Speech Percept. and Acoust. Labs., Speech and Hearing Sci. The Ohio State Univ., Columbus OH 43210-1002, chang.553@osu.edu)

The current study examines the effects of dialect variation on the time-course of lexical tone identification by native and non-native listeners of Mandarin Chinese. Listeners were asked to identify the tone of an isolated Chinese word presented without a precursor phrase. All stimuli were exemplars of V, CV, or CVC combinations that represented real words in Mandarin when produced with any of the four possible lexical tones. Words were produced by multiple talkers with a wide range of F0 values. The dialect of the talkers was also systematically varied. Half were native speakers of Beijing Mandarin, and the other half were native speakers of Taiwanese Mandarin. Preliminary acoustic analysis showed significant differences in tonal realization of the four lexical tones, especially Tone 3. There were three groups of listeners: native speakers of Beijing Mandarin and Taiwanese Mandarin and native English speakers who were learning Beijing Mandarin. A gating task was utilized to determine the temporal location in the token when the lexical tone was correctly identified and to examine the nature (and time course) of tone confusions. Results will be discussed in terms of the effects of dialect and F0 variation of the stimuli and the native language of the listener.

6pSWa12. Perception or production? Training effects on cross-language phonological awareness tasks in Mandarin-speaking children. Pi-Yu Chiang and Susan Rvachew (School of Commun. Sci. and Disord., McGill Univ., 1266 Pine Ave. West, Montreal QC H3G1A8, Canada, piyu.chiang@mail.mcgill.ca)

This study investigated training effects of perception-based and production-based English activities on the acquisition of phonological awareness of English sound structures by 58 Mandarin-speaking kindergarten-aged children in Taiwan. Children were randomly assigned to one of two experimental conditions or a control condition. Experimental groups participated in a learning session of four English words: band, nest, brick, and stool, with a perceptual or articulation focus on clusters, which do not exist in Mandarin. Outcome measures examined subjects' ability to match words on the basis of shared onset or coda, and to elicit common units in both Mandarin and English before and after training. Significant gain in English onset common unit test scores was observed for the production training group, relative to the control group, especially in trials containing the trained clusters: br- and st-. Perception group however did not show an improvement over time across all measures. Between-group differences were not observed for English codas, Chinese onsets, or Chinese codas. Findings revealed that clearly articulating non-native words with unfamiliar syllable structures could assist children to isolate onsets in explicit phonological awareness tasks, independent of exposure to alphabetic orthography, generally thought to be critical in explicit phonological awareness (e.g., Gombert, 1992).

6pSWa13. Learn to Listen (L2L): Perception training system for learners of English as a second language. Diane Kewley-Port (Commun. Disord. Technol., Inc. and Indiana Univ., Bloomington, IN), Kanae Nishi (Commun. Disord. Technol., Inc. and Boys Town Natl. Res. Hosp., Omaha, NE), Hanyong Park, James D. Miller, and Charles S. Watson (Commun. Disord. Technol., Inc. and Indiana Univ., Bloomington, IN)

Computer software (L2L) is being developed for comprehensive perception training of English by second language learners. Our goal is to facilitate generalization of post-training improvement of phoneme perception to the perception of running speech. Three studies are reported for two groups of adult listeners, one Korean and the other Spanish. In study 1, large sets of confusable phonemes were identified from an assessment task for each group. Then training sets for consonants in CV nonsense syllables and vowels

in familiar real words were selected and recordings from multiple talkers were obtained. Materials for the word-in-sentence (WIS) task were developed with a single low-context carrier phrase which contained three words from the vowel training. In study 2 new Korean and Spanish listeners were trained using a protocol that included a pre-test, eight hours of training, a post-test, and one hour using the WIS task. Training results showed: (1) both Korean and Spanish listeners improved from pre- to post-tests for vowels and consonants; (2) in vowel identification, Koreans outperformed Spanish by 34% (3) vowel identification in the WIS task appeared easier than in word-only task, a result confirmed by a study using the WIS task without training (study 3). [Work supported by NIH.]

6pSWa14. Effects of linguistic and musical experience on non-native perception of Thai vowel duration. Angela Cooper and Yue Wang (Dept. of Linguist., Simon Fraser Univ., 8888 Univ. Dr., Burnaby, B.C. V5A 1S6 Canada, akcooper@sfu.ca)

Previous research has suggested a relationship between musical experience and L2 proficiency. The present study investigated the influence of musical experience on non-native perception of speaking-rate varied Thai phonemic vowel length distinctions. Given that musicians are trained to discern temporal distinctions in music, we hypothesized that their musical experience would enhance their ability to perceive non-native vowel length distinctions as well as their sensitivity to temporal changes as a function of speaking rate. Naive native English listeners of Thai, with and without musical training, as well as native Thai listeners, were presented with minimal pairs of monosyllabic Thai words differing in vowel length at three speaking rates in an identification task and a discrimination task. For identification, participants were asked to identify whether a word contained a long or short vowel. For discrimination, participants heard three successive words and were asked to indicate whether the second word had the same vowel length as the first or last word. The results show significant group differences in identification and discrimination accuracy within and across speaking rates, suggesting that listeners' perception of phonetic categorical versus temporal acoustic variations differs as a function of linguistic and musical experience.

6pSWa15. Increased second-language vocabulary size is associated with more consistent second-language vowel categorization and better discrimination. Rikke L. Bundgaard-Nielsen (MARCS Auditory Lab., Univ. of Western Sydney, Bankstown Campus, Bldg. 1, Locked Bag 1797, Penrith South DC, NSW 1797, Australia, r.bundgaarnielsen@uws.edu.au), Catherine T. Best, and Michael D. Tyler (Univ. of Western Sydney, NSW 1797, Australia)

Improvement in second-language (L2) perception has been posited to asymptote early in L2 learning when the L2 vocabulary is still small, whereas a large L2 vocabulary curtails perceptual learning [PAM-L2: Best and Tyler (2007)]. We extend this proposition by suggesting that early L2 lexical development facilitates establishment of phonological categories in a manner analogous to toddlers' L1 acquisition before versus after the vocabulary explosion. According to this revised view, L2 speech should be assimilated more consistently to phonological categories, and cross-boundary contrasts discriminated more accurately, by learners with large versus small L2 vocabularies. We applied a novel whole-system approach to evaluate perception of L2 vowels with respect to the L1 vowel system. Japanese learners of Australian English with under 12 weeks of L2 immersion completed labeling and goodness ratings on all Australian vowels, using all mono- and bi-moraic Japanese vowels and vowel combinations. They also completed discrimination tasks on four L2 vowel contrasts, representing a range of PAM-L2 contrast types, and a L2 vocabulary size assessment. Learners with larger vocabularies had more consistent vowel assimilation and more accurate cross-boundary discrimination than those with smaller vocabularies, supporting the proposition that lexical development supports L2 phonological acquisition. [Work supported by NIH and MARCS/UWS.]

6pSWa16. The perception of Norwegian word tones by second language speakers. Wim A. van Dommelen and Olaf Husby (Dept. of Lang. and Comm. Studies, NTNU, N-7491 Trondheim, Norway, wim.van.dommelen@hf.ntnu.no)

The present study is concerned with the perception of Norwegian word tones by second language speakers. The phonological system of Norwegian involves two different tones that are used to distinguish a relatively large

number of word pairs. Earlier studies have shown that native speakers of Norwegian are able to identify the word tones almost error-free. The aim of the present study was to investigate word tone perception by speakers of a tonal language (Mandarin Chinese) and a non-tonal language (German). These two groups as well as a control group of native listeners identified manipulated stimuli with tonal contours varying between tone 1 and tone 2. It appeared that the L2 users had less sharp transitions than the natives, the Chinese subjects performing somewhat better than the Germans. In addition, native speakers categorized tokens of tone 1 and tone 2 words produced by the L2 speakers and indicated on a five-point scale how sure they were in their judgment. In an acoustical analysis the fundamental frequency contours of the L2 test words were analyzed and subsequently used for comparison with native categorization results. The implications of the found correlations between production and perception are discussed.

6pSWa17. Prominence perception: Conflicting cues and linguistically encoded bias. Miran Kim (Dept. of Linguist., State Univ. of New York at Stony Brook, S201 SBS Bldg., Stony Brook, NY 11794, mrkim@ic.sunysb.edu)

Beyond the commonly known fact that prominent syllables are greater in amplitude, higher in F0, and longer in duration, this study examines cross linguistic patterns in the perception of prominence. Particularly, identification of stress placement is tested in a situation where F0 and duration happen to be in conflict (e.g., H+L* bitonal pitch accent). Three languages are selected considering their prosodic characteristics such as phonological role of prominence and rhythm (stress-timed/syllable-timed): English, Spanish, and Korean. A new-language-learning setting is devised to collect production data based on which the patterns of phonetic realization of stress are directly compared among the language groups. CVCVCV pseudowords, where C=m, n, k, s and V=a, (e, i), are used for both production and perception experiments. F0 and duration are manipulated in order to create conflicting cues that are suitable for the purpose of the perception experiment. Stressed syllables are consistently realized with higher F0 together with longer duration across the groups, though to different extents. The perceptual sensitivity to the durational manipulation is found to vary among the groups. Linguistic implications are discussed referring to the phonological role(s) of F0 and duration in each language as well as to the relationship between production and perception.

6pSWa18. Perceptual attunement in infants at risk of reading disabilities. Christine Kitamura and Anna Herald (MARCS Auditory Lab., Bldg. 5, Bankstown Campus, Univ. of Western Sydney, Locked bag 1797, Penrith South DC, NSW, 1797, c.kitamura@uws.edu.au)

Impaired phonological processing has been found to have a reciprocal causal association with the reading ability of people with reading difficulties. Further, there is growing evidence that problems in phonological processing are present at birth as research shows that infants with a family history of these disorders have atypical neural electrical responses (ERPs) to speech stimuli. However, the nature of the phonological deficit is not clear. This study examined the phonological development of at-risk 9- to 12-month-old infants ($n=18$) and a control group ($n=18$). Their discrimination performance was evaluated using the habituation-dishabituation task to test their ability to discriminate the confusable native contrast, /fa-tha/ and the non-native contrast, /k'i-q'i/ from Werker and Tees (1984). In line with core phonological deficit hypothesis and hereditary accounts of reading difficulties, infants' attunement to their native language was significantly correlated with parental phonological ability measured using Pseudoword Decoding Test of the WIAT-II. The at-risk infants easily discriminated both native and non-native contrasts, whereas the control infants discriminated the native contrast but could not discriminate the non-native one. These results indicate that at-risk infants do not attune to their native language at the same rate as their peers.

6pSWa19. Effects of visual cues and phonetic contexts in perception of non-native contrasts by Cantonese learners of english. Bin Li (Dept. of Chinese, Translation & Linguist., City Univ. of Hong Kong, Hong Kong SAR, China)

Visual articulatory information, in addition to audio features, is integrated in L1 and L2 speech perception automatically and unconsciously [McGurk and MacDonald (1976); Rosenblum *et al.* (1997); Hardison

(2003); Hazan *et al.* (2005)]. Previous literature on consonant perception has reported that visual aid is most significant with places of articulation, and that with manners, except with /r/ and /l/, has received little attention due to lack of research significance. Contrary to the commonly held idea, however, that the articulation of [l] and [n] is visually similar, our examination on video recording of three native English speakers' production of words contrasting [l] and [n] syllable initially suggests visual differences in advancement of tongue tips. This study investigates effects of such visual information in the identification of the non-native contrast by Cantonese learners of English. Results show that the relatively more distinct visual information can only help Cantonese speakers better perceive the two sounds in certain contexts, and in others cause more confusion.

6pSWa20. Do words in the native language influence second-language speech perception? Evidence from Japanese listeners' perception of English words that exist as Japanese loanwords. Keiichi Tajima (Dept. of Psych., Hosei Univ., 2-17-1 Fujimi, Chiyoda-ku, Tokyo 102-8160, Japan, tajima@hosei.ac.jp)

It is well known that native-language (L1) sound structure influences adult learners' perception of second-language (L2) speech. However, it is not as clear whether L2 speech perception can also be influenced by L1 mental lexicon. Specifically, L2 words may be inaccurately perceived if familiar loanword counterparts exist in L1 and if these loanwords have different sound patterns from the original words. To examine this, the present study took advantage of Japanese loanwords from English (e.g., Japanese /sutoresu/ from English "stress"), which typically undergo syllable structure changes, and investigated whether Japanese listeners can accurately perceive the syllable structure of English words even when loanwords exist in Japanese. Thirty native Japanese listeners were asked to count syllables in 189 English words spoken by a native English talker, and rate their subjective familiarity with the English words and their loanword counterparts transcribed in Japanese katakana orthography. Results indicated that syllable-counting accuracy (65% on average) was not influenced by familiarity with the English words nor with the Japanese loanwords. Results suggest that even though loanwords resemble the original words in their sound and meaning, knowledge of such words in L1 does not necessarily influence perceptual processing of L2 words. [Work supported by MEXT and JSPS.]

6pSWa21. Predicting second language (L2) identification rates from first language (L1) mapping data: Similarity patterns for English and Korean obstruents in pre- and poststressed intervocalic, and postvocalic positions. Hanyong Park (Speech Res. Lab., Indiana Univ., 1101 E. 10th St., Bloomington, IN 47405, hanyongpark@indiana.edu) and Kenneth J. de Jong (Dept. of Linguist., Indiana Univ., Bloomington, IN 40405)

Park and de Jong [J.Phon, 36, 704-723 (2008)] found that listeners' identification rates of second language (L2) categories can be predicted from mapping data, provided the L2 category has a high degree of subjective correspondence to native language (L1) categories. The current study examines whether identification rates can be predicted for consonants in different prosodic locations, and hence, whether the reliance on L1 categories is the same, regardless of prosodic position. Forty native Koreans identified /p b t d f v θ/ in pre- and poststressed intervocalic, and postvocalic positions, in nonsense English words, using both Korean and English labels, and also gave gradient evaluations of their identifications. The mapping data were used to predict confusion rates for the L2 identification data, finding results for prestress intervocalic consonants similar to the previous study for word-initial consonants; stop identification rates were well-predicted, but fricatives are systematically much better than predicted. In poststress position, however, fricative identification rates were very well predicted, suggesting that fricatives were treated as "similar" to L1 categories. These results indicate that the degree of assimilation of an L2 to an L1 category is heavily dependent on prosodic location. [Work supported by NSF BCS-04406540.]

6pSWa22. Perception of foreign accent in Japanese and Brazilian Portuguese: Prosodic and segmental factors. Masahiko Komatsu (School of Psychol. Sci., Health Sci. Univ. of Hokkaido, Ainosato 2-5, Sapporo, 002-8072 Japan, koma2@hoku-iryo-u.ac.jp)

Japanese sentences read by Japanese-descent Brazilians (L2) and native Japanese speakers (L1) were rated by native Japanese speakers, and Portuguese sentences read by native Japanese speakers learning Portuguese (L2)

and Japanese-descent Brazilians (L1) were rated by Brazilians. The raters evaluated three types of samples: (a) sounds without spectral properties (representing prosodic features); (b) F0-flattened sounds (representing segmental features); and (c) unmodified sounds. In both languages, the perceptual scores of L1 and L2 samples were separated most clearly in (c), followed by (b) and (a). Both the scores of (a) and (b) showed strong correlations with (c) in L2. These suggest that both prosodic and segmental features play a role in the detection of foreign accent, but the latter has a greater effect. F0 characteristics varied between speaker groups rather than languages. The speaking rate in L2 was correlated with the perception scores. The effect of segmental features was greater in L2 Portuguese than in L2 Japanese, i.e., greater in less fluent speech. Foreign accents in both languages share common properties although having some differences. [This work is the revised version of Komatsu and Kimoto (2008) and Komatsu (in press), and partially supported by KAKENHI (20242010) and HSUH Ko-tai's grant.]

6pSWa23. Acquisition of new phonetic categories by bilingual and monolingual groups: Role of metalinguistic awareness and feature generalization. Divya V. Gogoi (Linguist. Program, Univ. of Florida, P.O. Box 115454, Gainesville, FL 32611) and James D. Harnsberger (Dept. of Commun. Sci. Disord., Univ. of Florida, Gainesville, FL 32611)

The present study examines the role of feature generalization and metalinguistic awareness in the perception and learning of novel non-native speech contrasts by 40 bilingual speakers (Bengali–English and Spanish–English) and 20 monolingual speakers of American English. Bilinguals, unlike monolinguals, employ certain cognitive and linguistic skills during lexical processing and word learning attributed as metalinguistic awareness. This awareness in turn, can be applied in mastering unfamiliar phonetic features in a third language. A second issue concerns the role that native phonetic features may play in the development of new phonetic categories involving same phonetic features (feature generalization hypothesis). To explore both factors, a high variability perception training paradigm was used to examine the acquisition of novel non-native speech contrasts (containing dental/alveolar-retroflex place distinction in various manners) from a target language, Malayalam. A consonant identification procedure was used throughout the training and testing phases of the experiment to examine post-test and generalization performance across groups. Productions of the stimuli were also recorded at the pretest and posttest phases. In addition, perceptual assimilation patterns were analyzed from consonant assimilation and discrimination scores before and after training.

6pSWa24. Dutch listeners' perception of Korean stop triplets. Mirjam Broersma (Radboud Univ. Nijmegen, Donders Inst. for Brain, Cognition and Behaviour, Ctr. for Cognition, P.O. Box 9104, 6500 HE Nijmegen, The Netherlands, mirjam@mirjambroersma.nl)

This study investigates Dutch listeners' perception of Korean stop triplets. Whereas Dutch distinguishes prevoiced and voiceless unaspirated stops, Korean distinguishes fortis, lenis, and aspirated stops. Here, perception of fortis, lenis, and aspirated bilabial (/pp/-p/-ph/), alveolar (/tt/-t/-th/), and velar (/kk/-k/-kh/) stops is investigated. In Dutch, VOT is the most important perceptual cue for initial stop voicing. Korean fortis stops fall within the VOT range of Dutch voiceless stops; VOTs of lenis and especially aspirated stops are longer than Dutch VOTs. Therefore, Dutch listeners were expected to distinguish fortis stops more accurately from the other two than lenis and aspirated stops from one another. In a phonetic categorization experiment, Dutch listeners categorized Korean stops in naturally recorded CVs as fortis/lenis, lenis/aspirated, or fortis/aspirated. Indeed, for all places of articulation, fortis stops were distinguished relatively accurately from the other two stops. The most difficult distinction was between lenis and aspirated stops (both outside the Dutch VOT range), the easiest distinction between fortis and aspirated stops (the former within the Dutch VOT range, the latter the most remote from Dutch VOTs). Thus, although all Korean VOT category boundaries are outside the Dutch VOT range, the distance from Dutch VOT values affected Dutch listeners' categorization.

6pSWa25. Effects of native language and amount of experience on crosslinguistic perception. Juli Cebrian (Dept. Filologia Anglesa, Fac. Filosofia i Lletres-Edifici B, Univ. Autònoma de Barcelona, Bellaterra 08193, Spain, juli.cebrian@uab.es)

Models of second language (L2) speech learning draw on the notion of perceptual similarity to make predictions about L2 perception and production difficulty. Crosslinguistic perceived similarity is commonly assessed by means of perceptual assimilation tasks involving identification of target stimuli and goodness of fit ratings. Further, experience with an L2 may affect the perception of not only target language vowels but also native vowels. This paper reports the results of a crosslinguistic perception study involving English and Catalan vowels and diphthongs. The study assessed the perceived similarity of the two vowel systems by testing native speakers of each language on sounds from both their native language and the foreign language. Vowels were presented in CVC syllables. The effect of learning a second language was investigated by comparing the performance of language learners and monolingual speakers on the same task. The comparison between the two monolingual groups indicated a symmetry in the pattern of crosslinguistic perceived similarity while the effect of experience was found to vary with different vowels. The results are discussed in light of current theories and their predictions for second language perception and production. [Work supported by Grants HUM2005-02746/FILO (Spanish Ministry of Education) and 2005SGR00864 (Catalan Government).]

6pSWa26. Experience effects on the categorization of a native vowel contrast in highly proficient Catalan-Spanish bilinguals. Joan C. Mora (Dept. Filologia Anglesa, Universitat de Barcelona, Gran Via 585, 08007-Barcelona, Spain, mora@ub.edu) and Marianna Nadeu (Univ. of Illinois at Urbana-Champaign, Urbana, IL 61801)

The present study investigated the effect of experience on highly proficient adult Catalan-Spanish bilinguals' ability to categorize two contrastive native vowel categories, /e/ and /e/. Experience was operationalized as self-reported amount of use of Catalan on a daily basis. Because Spanish has a single mid front vowel /e/ in the area of the perceptual vowel space of the Catalan mid vowels /e/ and /e/, categorization and discrimination speed and accuracy was hypothesized to vary as a function of amount of use of Catalan and Spanish, more experienced Catalan speakers performing faster and perceiving the contrast more categorically. All participants ($N=43$) were L1-Catalan bilinguals, but differed as regards the amount of use of Catalan ($N=14$, $M=62.1$, range 40–70 vs $N=29$, $M=91.4$, range 80–100). Experience effects were assessed through the categorical perception paradigm: categorization and AXB discrimination tasks based on stimuli drawn from a 10-step vowel continuum (/e/-/e/). Response latency data revealed that the high-use-of-Catalan group outperformed the low-use-of-Catalan group, suggesting that greater use of Catalan on a daily basis improved bilinguals' ability to categorize and discriminate this vowel contrast. These results are interpreted as being consistent with the view that L1 and L2 experience affects the perception of L1 sounds.

6pSWa27. The influence of lexical access and linguistic context on second-language (L2) speech perception. Mara Haslam (Dept. of Linguist., Univ. of Utah, 255 S. Central Campus Dr., Rm. 2300, Salt Lake City, UT 84112, m.haslam@utah.edu), Albert Jarvi (Univ. of Illinois Urbana-Champaign, Urbana, IL 61801), and Rachel Hayes-Harb (Univ. of Utah, Salt Lake City, UT 84112)

Research on the perception of novel phonemic contrasts by second language (L2) learners typically employs tasks such as identification and discrimination. These tasks allow researchers to study L2 speech in a highly controlled setting. However, they differ in important ways from natural communication, which normally requires learners to (1) access lexical representations of words containing novel contrasts, and (2) interpret linguistic context (e.g., syntax, semantics, discourse) while simultaneously perceiving/producing novel contrasts. This study investigated whether learners' perceptual performance with respect to novel contrasts is mediated by whether or not tasks require lexical access (LA) and/or the simultaneous interpretation of linguistic context (SILC). Native English speakers learned Ukrainian auditory nonword pairs differentiated by palatalization contrasts along with pictured "meanings." An ability to distinguish the words was tested in tasks differing on the two dimensions (LA and SILC). Performance was most accurate in the noLA + noSILC task, least accurate in the LA + SILC and noLA + SILC tasks, and intermediate in the LA + noSILC task, indicating that both LA and SILC appear to depress perceptual accuracy. However, the effect of SILC is stronger than that of LA. Future directions and implications for the study of L2 perception/production will be discussed.

6pSWa28. Word-level rhythm in non-native English. Rachel E. Baker (Dept. of Linguist., Northwestern Univ., 2016 Sheridan Rd., Evanston, IL 60208-4090, r-baker2@northwestern.edu), Laurent Bonnasse-Gahot (Ecole des Hautes Etudes en Sci. Sociales, Paris 75006, France), Kristin J. Van Engen, Melissa Baese-Berk, and Midam Kim (Dept. of Linguist., Northwestern Univ., Evanston, IL 60208-4090)

Motivated by traditional rhythm class typologies, studies of language-learners' rhythm typically focus on the syllable or segment level. Studying word-level rhythm lets us explore the effects of lexical features (e.g., part of speech, predictability) on word durations in non-native speech. This study examined whether native and non-native English can be distinguished by variation in the realization of English lexical features, and whether non-native-like word-level rhythm leads to a stronger foreign accent. Word durations were measured in English paragraphs read by 12 native American English (AE), 20 native Korean, and 20 native Chinese speakers. AE listeners rated the "accentedness" of these speakers. AE speakers showed greater within-speaker word duration variance than non-natives, and non-native speakers with greater variance received more native-like accent ratings. Increased AE variance had two causes. AE speakers had shorter relative durations for function words than non-natives. AE speakers also showed greater variance in their content word durations than non-natives, perhaps due to differences between words with and without pitch accents. However, both AE and non-native speakers produced shorter second mentions of words than first mentions, showing sensitivity to lexical predictability. Overall, these findings implicate word-level rhythm as an important and complex feature of foreign-accented English.

6pSWa29. English vowel contrast perception on monolingual and bilingual 4- to 7-year olds: Behavioral and neurophysiological evidence. Yan Yu, Nancy Vidal, Hia Datta, Jennifer Gerometta, and Valerie Shafer (Speech-Lang.-Hearing Sci., the Graduate Ctr., City Univ. of New York, New York, NY 10016)

The role of simultaneous bilingual language exposure on speech perception development has been far from definitive. Behavioral literature has been controversial in terms of whether bilingual children keep pace with their monolingual peers [Burns *et al.* (2007); Sundara *et al.* (2006)]. The purpose of the current study is to: (1) investigate whether bilingual exposure to Spanish and English affects processing of speech stimuli that are phonemic only in English in children from 4–7 years of age; (2) whether the event-related potential (ERP) measures correlate with the behavioral measure (e.g., phoneme identification). Phonetically similar vowel contrasts (I versus E) were presented in an oddball paradigm while ERPs were collected from 65 scalp sites. Vowel discrimination and vowel identification were carried out using I-E vowel continuum. Preliminary analyses suggest that there is no difference in how monolingual and bilingual children behaviorally identify this vowel contrast. In terms of the ERP responses, children in both groups showed vowel discrimination as indexed by the presence of mismatch responses (MMRs). Younger children tended to still have a positive MMR that preceded the adult-like negative MMR. Individual patterns of response will be discussed in relation to amount of English versus Spanish exposure.

6pSWa30. Using voice quality to learn non-native tonal categories. Kristine M. Yu (Dept. of Linguist., Univ. of California, Los Angeles, 3125 Campbell Hall, Los Angeles, CA 90095, krisyu@humnet.ucla.edu)

An artificial language learning experiment will be used to study if voice quality can be used to learn tonal systems. Cross-linguistically, tone, and voice quality can co-vary in different ways. For instance, Mazatec (Jalapa de Diaz), has three phonation types (modal, breathy, creaky) fully crossed with three level tone levels [Ladefoged *et al.* (1988)], while Mandarin has creaky phonation in Tone 3 and Tone 4, which are also distinguished from one another and Tone 1 and 2 by f₀ contour [Davison (1991); Belotel-Grenié and Grenié (2004)]. The goal of the study is to investigate if English listeners unfamiliar with tone languages can use phonation-type contrasts to learn tonal contrasts in artificial tone languages differing in how tone and voice

quality co-vary. There will be a comparison of how learners generalize from training to novel stimuli for artificial languages where voice quality and tone contrasts are correlated and uncorrelated cues.

6pSWa31. Intelligibility of Spanish-accented English words in noise. Jonathan Dalby (Dept. of Audiol. and Speech Sci., Indiana Univ.-Purdue Univ., Fort Wayne, 2101 E. Coliseum, Ft. Wayne, IN 46805, dalbyj@ipfw.edu) and Catherine L. Rogers (Univ. of South Florida, Tampa, FL 33620)

The intelligibility of Mandarin-accented English sentences, even those spoken by highly proficient non-native speakers, is degraded more than is native speech when presented to native listeners in noise [Rogers *et al.* (2004)]. Comprehension of accented speech may require more processing time than native speech even when presented in quiet [Munro and Derwing (1995)]. These effects are similar to effects found by Pisoni and his colleagues for synthetic, as compared to natural speech [Winters and Pisoni (2003)] and together suggest that the ability of native listeners to adapt relatively quickly and effectively to accented speech [Bradlow and Bent (2008); Clark and Garrett (2004)] may come at the expense of increased cognitive effort. The present study examines the effects of noise on the intelligibility of Mandarin-accented isolated words from speakers representing a wide range of oral English proficiency based on connected-speech measures. A subset of these words, those with the highest open-set identification scores as rated by a jury of 10 native listeners, will be presented for identification to a second jury at four signal-to-noise ratios: quiet, +10, 0, and –5 dB. Results are compared to those found for connected speech from the same group of talkers. [Work supported by NIH-NIDCD.]

6pSWa32. Infant dialect discrimination. Jennifer Phan and Derek M. Houston (Dept. of Otolaryngol., Indiana Univ. School of Medicine, 699 West Dr., Indianapolis, IN 46202, jphan@iupui.edu)

To understand speech, infants must differentiate between phonetic changes that are linguistically contrastive and those that are not. Research has shown that infants are very sensitive to fine-grained differences in speech sounds that differentiate words in their own or another language. However, little is known about infants' ability to discriminate phonetic differences associated with different dialects of their native language. Using a visual habituation procedure, 7-, 11-, 18-, 24-, and 30-month olds were tested on their ability to discriminate two linguistically equivalent variants of the diphthong (/aI/)—one produced in their native dialect (North Midland American English) versus one produced in a non-native dialect (Southern American English). Seven-month olds discriminated the variants but 11-month olds did not. Infants from 18–30 months of age did not demonstrate statistically significant discrimination, but they did show a trend toward discrimination with increasing age. The findings suggest that dialect discrimination follows a U-shaped course of development. Because 11-month olds demonstrated the poorest dialect discrimination performance, we are currently assessing their ability to discriminate linguistically different speech sounds varying in degree of acoustic similarity. Preliminary findings suggest that both language experience and acoustic differences may influence infants' discrimination of phonetic contrasts in the native language. [Work supported by NIH-NIDCD Grant (R01DC006235), an IUPUI Educational Enhancement Grant, and grants from the IUPUI UROP and SROP Programs.]

6pSWa33. Perception of second-language (L2) production by first-language (L1) speakers of different dialectal backgrounds: The case of Japanese-speaking learners' /u/ perceived by French and Quebec native speakers. Marie-Claude Tremblay (Dept. of Linguist., Univ. of Ottawa, 70 Laurier Ave. E., Ottawa, ON Canada, K1N 6N5, mtrem075@uottawa.ca) and Takeki Kamiyama (CNRS/Sorbonne Nouvelle, 75005 Paris, France)

The high back rounded /u/ of Parisian French (PF) is characterized by a concentration of energy in the low frequency zone (< 1000 Hz) due to the grouping of the first two formants, while Quebec French (QF) has a "lax" variant [u] in closed syllables (as in "soupe"), with its F₂ amounting to 1000–1100 Hz [P. Martin, "Le système vocalique du français du Québec. De l'acoustique à la phonologie." *La linguistique*, 38(2), 71–88 (2002)]. Japanese-speaking learners of French (JSL) tend to produce French /u/ with high F₂ as in Japanese /u/, which in turn tends to be perceived by PF lis-

teners as / ϕ /. Do QF listeners show different behavior because of their lax variant of /u/? Our perception experiment using 18 tokens each of /u y ϕ / produced by five JSL showed that the 16 PF listeners examined perceived those stimuli of /u/ with F2 between 1000 and 1100 Hz as /u/ and / ϕ / almost equally often, but considered as very poor exemplars of either of them. By contrast, the 16 QF listeners tested identified the same stimuli of /u/ almost always as /u/ with a better goodness rating than NF listeners'. These findings suggest that native speakers' judgment about non-native speakers' production might depend on the native dialect of the listener.

6pSWa34. Adapting second language phonemic perception training to common instructional situations: Pitfalls and progress. Thomas R. Sawallis and Michael W. Townley (English Dept., Univ. of Alabama, Box 870244, Tuscaloosa, AL 35487, tsawalli@bama.ua.edu)

Adult language learners improve both perception and production of difficult target language phonemic contrasts through high variability phonetic training (HVPT) on minimal pairs. This training entails two alternative forced choice identifications with feedback of a corpus encompassing multiple talkers, tokens, and phonological contexts. This technique, refined most notably by Pisoni and colleagues [Bradlow *et al.* (1999)], has been little used in real pedagogical situations, due partly to inconvenient protocols (e.g., 1 h, 3 days per week, for 3 weeks) and partly to the difficulty of developing a robust presentation routine attractive to students. We have attacked these problems, and after two semesters of pilot work refining the training presentation (of English /r-l/ to Japanese, Korean, and Chinese native learners), we expect this semester to have students who receive a full complement of training at ~15 min, 2–3 days per week, throughout the term. Results will be presented and compared with previous research, and we will discuss some of the difficulties (technological, practical, and especially social) that were overcome for the sake naturalistic pedagogical application.

6pSWa35. Effects of first-language (L1) voicing assimilation rules on the second-language (L2) perception of English word-final consonants by Polish and Hungarian listeners. Marisa A. Monteleone (Dept. of Linguist., The Graduate Ctr., City Univ. of New York, 365 Fifth Ave., New York, NY 10016)

This study explores whether knowledge of a L1 regressive voicing assimilation rule interferes with perception of word-final voicing contrasts in an L2. Due to a regressive voicing assimilation rule, voicing in word-final consonants is neutralized in both Hungarian and Polish. American English (AE) maintains a voicing contrast in this same context. In a perception task, 11 native Hungarian and 12 native Polish listeners identified AE word-final consonants (e.g., [s]-[z]) followed by voiced versus voiceless consonants. In a separate task, they identified the same consonants with the following consonantal context removed. The Hungarian and Polish listeners performed less accurately when the following context was present than when it was removed, suggesting that word-final perception was influenced by the interference of the L1 rule.

6pSWa36. Cross-language differences in the uptake of place of articulation. Anita E. Wagner (Dept. of Speech, Hearing and Phonetic Sci., Univ. College London, London, UK)

There are cross-language differences in the use of coarticulatory cues for native identification. Listeners with spectrally similar fricatives in their native phoneme inventories rely more on the information in the surrounding vowels than listeners with spectrally distinct fricatives. The present study examined whether such cross-language differences result in differences in the temporal uptake of information specifying fricatives. In a gating study native listeners of Dutch and Italian, both languages with spectrally distinct fricatives were compared with Spanish and Polish listeners. The Spanish fricative inventory contains the spectrally similar labiodental and dental fricatives. The Polish fricative repertoire contains postdental, alveolar, and alveopalatal fricatives. The questions addressed were whether the presence of spectrally similar fricatives leads to: (1) reliance on cues, which are secondary for listeners with distinct fricatives; (2) an uptake of information specifying place of articulation in particular for fricatives; (3) an uptake of information from coarticulatory cues preceding or following the consonant. Listeners identified fricative and stop targets in gated CV and VC syllables. The results show that listeners optimize their uptake of information to the

demands of their native phoneme inventories and rely on more sources of information only for distinctions between several similar places of articulation.

6pSWa37. Coarticulatory influences on the perception of nasal vowel height and the role of language experience. C. Elizabeth Goodin-Mayedá (Dept. of Spanish and Portuguese, Univ. of California, Los Angeles, 5310 Rolfe Hall, Los Angeles, CA 90095, cegoodin@ucla.edu)

That a listener's first language affects the perception of a second language is generally undisputed. In addition to linguistic experience, acoustic effects of coarticulation have been shown to influence speech perception [Abramson *et al.* (1981); Krakow *et al.* (1988); Mann (1986) and others]. For example, nasalization of vowels has been shown to affect the perception of vowel height due to its spectral consequences in the region associated with vowel height [Beddor and Strange (1982); Krakow *et al.* (1988); Ohala (1986); Wright (1975)]. While some effects of coarticulation appear to produce the same perceptual shifts crosslinguistically [Mann (1986)], it is not clear that all coarticulatory influences are language independent [Krakow *et al.* (1988)]. The current study seeks to investigate the relationship between acoustic effects of coarticulation and linguistic experience. Since Portuguese has allophonic and (surface) contrastive nasalization [Wetzels (1997)] and Spanish does not have phonological nasalization in any context [Solé (1992)], adult speakers of these languages were tested, using synthetic stimuli, for perception of contextualized nasal vowels (i.e., nasal vowels adjacent to tautosyllabic nasal consonants) and noncontextualized nasal vowels (i.e., nasal vowels with no adjacent nasal consonant). Results indicate that coarticulatory influences of nasalization are language dependent.

6pSWa38. Perception of consonant length by Russian and American listeners. Olga Dmitrieva (Dept. of Linguist., Stanford Univ., Margaret Jacks Hall, Bldg. 460, Stanford, CA 94305, dmitro@stanford.edu)

An experimental investigation of Russian geminates revealed that intervocalic, post-stress, and word-initial geminates have an earlier perceptual boundary in relation to the average singleton duration in these positions. This provides an articulatory and perceptual advantage for geminate production and discrimination, which may explain cross-linguistic preference for these types of geminates. The proximity of the boundary to the average singleton means that a smaller articulatory effort is needed to reach the geminate status; its greater distance from the average geminate means that fewer intended geminates are misperceived as singletons, hence less danger of perceptually driven neutralization. To confirm that this generalization holds across languages a group of monolingual American English listeners was tested in addition to Russian listeners. The results strongly suggest that perception of the contrast between geminates and singletons has a linguistically universal basis. Speakers of American English—a language without phonemic consonant length—showed a pattern of responses very similar to that of the Russian listeners, in particular for post-stress and intervocalic geminates. The consistency of the results in both languages further supports the hypothesis that the observed shift in perceptual boundary is responsible for cross-linguistic dominance of intervocalic and post-stress geminates.

6pSWa39. Cross-linguistic perception of the epenthetic vowel in obstruent + liquid clusters in Spanish. Carlos Ramirez (Dept. of Hispanic Lang. and Lit., Univ. of Pittsburgh, 1301A Cathedral of Learning, Pittsburgh PA 15260, cjamirez@hotmail.com)

This research explores the perception of the epenthetic vowel (EV) that occurs in the obstruent + liquid clusters in Spanish. The perceptibility of EV and its effect in the cluster is analyzed in Spanish native speakers and English native speakers learning Spanish at different levels: beginners; intermediate; and advanced. For this study, two tests were used: a perceptual identification test and a discrimination test (AXB protocol). The study explores the effect of linguistic and prosodic variables such as place and manner of articulation, voicing, type of liquid, and stress. The statistical analysis was conducted using mixed logit models, which can better account for subject and item random effects. This procedure, in contrast to other analyses, builds a model that predicts the effect of each factor. The results show that the different groups use different cues. For English speakers, place, voicing, and stress are predictors for the beginner and intermediate group (WaldZ = 0.000p < 0.000) whereas only voicing is a predictor for the advanced group (WaldZ = 0.008p < 0.01). For the Spanish native speakers voicing

and stress are predictors ($\text{WaldZ} = 0.02p < 0.05$). The results suggest that perceptual cues vary according to L1 and proficiency level.

6pSWa40. Language background influences the emergence of voice onset time production and perception. Andrea A. N. MacLeod (Pavillon Vandy, Univ. Laval, PQ, QC G1S 3H3, Canada), Susan Rvachew, and Linda Polka (McGill Univ., Montreal, QC H3G 1A8, Canada)

This study investigates the production and perception of voice onset time (VOT) among preschool children who acquired English and French simultaneously compared to monolingual peers of these two languages. Children participated in this study at the age of 18 months and returned at 24 months for a second session. During each session the children took part in a visual habituation procedure to evaluate discrimination of VOT using edited natural /b/+ vowel and /p/+ vowel syllables in a task format developed by Houston et al. (2007) to assess individual performance. In this task, three VOT values (produced by several talkers) were presented to the children: one within adult norms of the language for voiced bilabial consonants; one within the adult norms of the language for voiceless bilabial consonants; and one between the means for the voiced and voiceless consonants. The children also participated in a structured play session, and their spontaneous productions of word initial stops were acoustically analyzed to measure VOT. Preliminary analysis indicates that accuracy in discriminating VOT precedes production of voicing contrasts for all groups, and monolinguals appear to have developed adultlike perception and production of voicing at a younger age than their bilingual peers.

6pSWa41. Perception of Moroccan Arabic geminates by native English speakers. Bozena Pajak (Dept. of Linguist., Univ. of California San Diego, 9500 Gilman Dr. #108, La Jolla, CA 92093, bpajak@ucsd.edu)

Adult listeners often have difficulty perceiving phonetic distinctions that are not contrastive in their native language (e.g., Lisker and Abramson 1970, Miyawaki et al. 1975, Trehub 1976, MacKain et al. 1980, Werker et al. 1981, among others). However, the same contrast may be perceived with more or less difficulty depending on the environment in which it is embedded. This study investigated the perception of geminate consonants in Moroccan Arabic by native English speakers who had not had previous exposure to the geminate-singleton contrast. The geminates [ss] and [zz] were paired with singleton counterparts in four different environments: medial-

intervocalic ([assa]-[asa], [azza]-[aza]); medial-consonant-adjacent ([assta]-[asta], [azzda]-[azda]); initial-vowel-adjacent ([ssa]-[sa], [zza]-[za]); and initial-consonant-adjacent ([sstta]-[sta], [zzda]-[zda]). The words were recorded by a native Moroccan Arabic speaker, and subsequently used as stimuli in a perception experiment (AX discrimination task; 80 participants). The sensitivity to the geminate-singleton contrast was measured by calculating A-prime scores (Grier 1971) and performing an ANOVA. The analysis showed a significant main effect of environment [$F(3,237)=28.7; p<0.001$]. The participants performed above chance, and their perception of the geminate-singleton contrast was best in the medial-intervocalic environment ($A'=0.83$), worse in the medial-consonant-adjacent ($A'=0.73$) and initial-vowel-adjacent environments ($A'=0.74$), and worst in the initial-consonant-adjacent context ($A'=0.58$).

6pSW42. Stop-like modification of dental fricatives in Indian English: A preliminary study to perceptual experiments. Chi D. Chu (Dept. of Linguist., Dartmouth College, 4954 Hinman, Hanover, NH 03755, chi.chu@dartmouth.edu) and Nancy F. Chen (MIT, Cambridge, MA 02139)

Stop-like modification of dental fricatives occurs in both American English and foreign accents of English (Zhao, Ph.D. thesis, 2007). This study examines stop-like word-initial /ð/ in Indian English to determine its frequency and compare it with American English. Acoustic analysis on unscripted telephone recordings of 40 Indian English speakers showed that of 161 total word-initial /ð/ instances, 61% were stop-like. The modification occurred most frequently in utterance-initial contexts, after stops, and after fricatives, and least after vowels and liquids. The variable occurrence of the modification across many contexts suggests that it may result from physiological conditions rather than from a phonological rule. If the modification is physiologically conditioned, differences in modification frequency between dialects may indicate dialectal differences in articulation. For example, comparison with American English showed that stop-like /ð/ was more common in Indian English across all contexts, particularly after fricatives, consistent with the tendency of Indian English to substitute bilabial stops for labiodental fricatives (e.g., /f/ and /v/), which provides a context more conducive to stop-like /ð/. Further investigation of varying cross-dialectal frequencies of stop-like modification could uncover additional dialectal differences in articulation and determine how such articulatory differences might affect cross-dialect perception.

SATURDAY AFTERNOON, 23 MAY 2009

SKY BRIDGE AUDITORIUM, 3:15 TO 4:45 P.M.

Session 6pSWb

Speech Workshop: Development of Speech Perception: Shaping the Acquisition of Spoken Language

Terry L. Gottfried, Chair

Dept. of Psychology, Lawrence Univ., Appleton, WI 54912-0599

Contributed Papers

3:15

6pSWb1. Newborn infant perception of vowels is affected by ambient language. Christine Moon (Pacific Lutheran Univ., Dept. of Psych., Tacoma, WA 98447, mooncm@plu.edu), Hugo Lagercrantz (Karolinska U. Hospital Solna, S-171 76 Stockholm, Sweden), and Patricia K. Kuhl (Univ. of Washington, Seattle, WA 98195)

Behavioral research has shown that by 6 months of age, infants show an effect of experience with native language vowels. In a previous study of category organization, infants in Sweden and the United States treated a vowel prototype as equivalent to variants of the vowel in the native, but not the non-native language. In the current behavioral study of Swedish and U.S. neonates, results were consistent with those of the 6-month-olds. Eighty infants ($M=32.8$ h since birth) in Washington State and Stockholm participated in a procedure in which non-nutritive sucking activated one of 17

stimuli (a prototype and 16 variants) from the same vowel category. Twenty infants in each country heard their native vowel, and 20 the non-native vowel. The vowels were English /i/ and Swedish /y/. Stimuli were serially and randomly activated by the onset of a sucking bout, and once a stimulus was activated, frequency of presentation was infant-controlled. The dependent measure was number of sucks for each stimulus. For the non-native vowel only, the mean number of sucks was significantly higher for the prototype than the mean for the 16 variants. This suggests that category organization of vowels begins *in utero*.

3:33

6pSWb2. Visual speech information improves discrimination of non-native phonemes in late infancy. Robin K. Panneton (Dept. of Psychology, Virginia Tech., Blacksburg, VA, panneton@vt.edu)

Initially, human infants are able to discriminate a change from one speech phoneme to another, whether or not the speech contrasts are native or foreign. By the end of the first postnatal year, the ease with which infants discriminate non-native phonemes diminishes, indicating a progressive attunement toward language-relevant speech. However, studies in this area have employed procedures lacking dynamic bimodal information (e.g., faces and voices). Given rapid improvements in visual perception across the first postnatal year, as well as a strong propensity to look at and process faces, it is possible that infants would benefit from visual speech in both native and non-native perception. Across two experiments, discrimination of auditory plus visual Hindi phoneme contrasts was studied in 11-month-olds (English-learning, using digital movies of female Hindi speakers). Several conditions were contrasted: (a) face plus voice using infant-directed speech (IDS); (b) face plus voice using adult-directed speech (ADS); (c) nonface plus voice with IDS; and (d) nonface plus voice with ADS. Overall, infants discriminated non-native contrasts when accompanied by a dynamic face, and especially if delivered in IDS. These results suggest a developmental pattern toward increasing use of multimodal information by infants in their processing of speech, and that early phonological representations for native language may include visual speech information.

3:51

6pSWb3. Brain, behavioral, and sociocultural factors in bilingual language learning. Adrian Garcia-Sierra, Maritza Rivera-Gaxiola, Barbara Conboy (I-LABS, Univ. of Washington, Fisheries Ctr. Bldg., Box 357988, Seattle, WA 98195-7988), Harriet Romo (Univ. of Texas, San Antonio, San Antonio, TX 78201), Lindsay Klarman, and Patricia Kuhl (Univ. of Washington, Seattle, WA 98195-7988)

Previous behavioral studies have shown improved sensitivity to native-language contrasts and reduced sensitivity to non-native phonetic contrasts when comparing 6–8- and 10–12-month-old monolingual infants. It has been argued that exposure to language dedicates neural networks to the acoustic properties of native-language speech, and that, in adulthood, this commitment interferes with nonnative speech processing [native language neural commitment or (NLNC)]. There are very few studies on how early speech perception in bilinguals relates to future language advancement. Recently it has been shown that infants' early native-language speech perception skill predicts their later success at language acquisition. In the present investigation, we examined how brain measures of speech perception in bilingual infants and socio-cultural factors of their environment predict later vocabulary growth. Our results showed excellent neural discrimination of both English and Spanish phonetic contrasts in 12-month-old infants, distinguishing them from monolingual infants. To our knowledge, this is the first study of bilingual infants using a brain measure to show that bilingual infants' speech specialization includes both languages by the end of the first year of life.

4:09

6pSWb4. Bilinguals mind their language (mode): Vowel perception patterns of simultaneous bilingual and monolingual speakers. Monika Molnar, Linda Polka (McGill Univ., 1266 Pine Ave. W, Montreal, H3G 1A8 Canada; monika.molnar@mcgill.ca), Lucie Menard (Univ. du Québec à Montréal, Montreal, Canada), and Shari Baum (McGill Univ., Montreal, H3G 1A8 Canada)

It is well-established that the speech perception abilities of monolingual speakers are highly tuned to the sounds of their native language, and that this language specificity affects how monolingual speakers distinguish the sounds of a non-native language. The present study addressed how the speech perception skills of simultaneous bilingual speakers, who are native speakers of two languages, may be affected by control of active language mode. We tested monolingual (English and French) and simultaneous bilingual (English/French) adults in an identification and rating task with 42 vowels along a continuum from a high back rounded vowel (/u/) to a high front rounded vowel (/y/) that are both phonemic in French, with only the back vowel represented in English. Bilinguals completed the task in three language modes: English, French, and bilingual. As expected, monolingual speakers demonstrated a language-specific perceptual pattern for the vowels. Bilingual participants displayed different perceptual patterns in each active language mode to accommodate the vowel categories relevant in the target language. These findings indicate that simultaneous bilinguals rely on a finely detailed perceptual space and are flexible as they adapt their perception to different language environments.

4:27

6pSWb5. Korean-English bilinguals' perception of phonetic contrasts in their two languages. Jessica Maye (Commun. Sci. and Disord., Northwestern Univ., 2240 Campus Dr., Evanston, IL 60208, j-maye@northwestern.edu), Jenna Luque (Northwestern Univ., Evanston, IL 60208), Thomas Farmer (Cornell Univ., Ithaca, NY 14850-2824), Yubin Lee, and Midam Kim (Northwestern Univ., Evanston, IL 60208)

Korean speakers are known to find English /r/-/l/ difficult to discriminate, and English speakers have trouble discriminating Korean voicing contrasts. We tested Korean-English bilinguals' perception of these difficult phonetic contrasts to examine the effects of age of acquisition and language dominance on bilinguals' perception in their two languages. All bilingual participants were native Korean speakers but varied in age of English acquisition. Some reported English to be their dominant language, while others were Korean-dominant. Participants completed a 2AFC task in which they were asked to click on one out of a pair of pictures. On key trials the pictures formed a minimal pair (e.g., rock versus lock). The same task was completed once in English (key items contained the /r/-/l/ contrast) and once in Korean (key items contained the plain versus tense voicing contrast). Earlier exposure to English led to greater accuracy and faster response on the English task. However, neither age of acquisition nor language dominance affected performance on the Korean task. These results suggest that earlier exposure to a second language improves perception in that language, but that loss of dominance in a first language does not impair phonetic processing of that language. [Work supported by NIH#1R03HD048538 to JM.]

Session 6pSWc

Speech Workshop: Closing Address

Linda Polka, Chair

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Chair's Introduction—5:00

Invited Papers

5:05

6pSWc1. Looking back to see where we're going. James Jenkins (Dept. of Psych., Univ. of South Florida, Tampa, FL 33612, J3cube@aol.com)

A brief sketch of the origins of the field of cross-language speech perception will be presented. This will be followed by comments on the current state of research as reflected in the workshop and suggestions as to future directions.